Chemical & Process Engineering

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New Sources of Energy

THE incipient shortage of the world's most important resource—energy—was recently referred to by Mr. William C. Foster, president of the U.S. Manufacturing Chemists' Association Inc., as a global problem which may become more important than the present clash of ideologies. Enumerating some possible new sources of energy, he mentioned nuclear energy, solar energy and the 'fuel cell' for converting heat directly into electrical or chemical energy without the intervention of a mechanical device. Another temporary aid is the development of second-grade sources such as shale oil.

One thing common to all these possibilities, he pointed out, is that they involve the use of chemicals, chemical processes and chemical techniques.

Certainly the chemical technologist has a big responsibility in this matter, and Mr. Foster's warning should be heeded, for it will do no good to rest complacent on this question of energy, waiting for atomic energy to supply the complete answer. No possible new source of energy should be left unexplored. For this reason, it is good to note that, in the face of the scepticism that has been expressed by some atomic scientists, a U.S. firm of aircraft manufacturers is sticking doggedly to its intention to try out a possible new way of releasing a tremendous store of usable energy by subjecting carbonaceous matter, *e.g.* coal, to a fission process. The firm is the Fairchild Engine & Airplane Corporation and the idea originated from a retired U.S. Army officer, Col. H. Hardsog, now employed by Fairchild. Whether anything comes of this idea or not and no matter what the sceptics say, it should be hailed as a worthy attempt to solve the energy problem by yet another means.

In Britain recently, attention has been drawn to a further untapped source of energy—the osmotic and other forces which might be brought into play when a quantity of sea water is mixed with a quantity of fresh water, and which might be used to produce electrical power. What appears to be the most practicable method depends on the ionic nature of salt and uses membranes (incorporating ion-exchange resins) selectively permeable to ions of one sign or the other. If such a membrane separates two salt solutions of different strengths, a potential difference appears across it.

An apparatus (the 'hydroelectric pile') has been constructed; in it 47 acidic and 47 basic membranes are separated by 93 spaces. Fresh and salt water pass through a system of holes and washers and flow across

alternate spaces between the membranes, and current is led off from compartments at the ends of the pile. A continuous supply of electricity is thus obtained. This apparatus, which seems likely to prove more economic in a warm and equable climate, has been described by R. E. Pattle in *Nature*, 1954, **174** (10), 660.

Something is bound to come of all this experimenting with fuel cells, solar energy and the like. If it should ever become possible and economical to produce large supplies of power by utilising natural forces — sun, water, even wind — this means would have much to recommend it over any system involving the consumption of hard-won minerals such as uranium and coal.

Pumping coal through pipelines

BECAUSE of the high costs of underground transport, the coal mining industry is investigating new forms of coal movement from the coal face. Solids suspended in liquids have been pumped in a number of industries and the principle is being used notably in heavy medium coal preparation plants. Until recently not enough was known about the hydrodynamics of such suspensions to enable large permanent installations to be designed for continuous and reliable service and at maximum economy.

The first considerable research on these problems was carried out in France by the Laboratoire Dauphinois d'Hydraulique. Following some preliminary work at the National Coal Board's Stoke Orchard station, it was decided to invite the British Hydromechanics R.A. to take over this project as a research sponsored by the N.C.B.

In a lecture delivered to the Royal Society of Arts on January 19, Dr. W. Idris Jones, C.B.E., Director-General of Research of the N.C.B., has given some account of the considerable progress that has since been made in the accumulation of the scanty existing data and supplementing these by controlled experiments on various pipelines in the laboratory.

Enough is now known to prove that the method should be reliable and economic, and to justify the development of the various specialised mechanisms which will be needed. Work will therefore be concentrated on systems for raising coal from the working levels of the pits to the surface, since the hydrodynamics of these vertical systems are relatively simple.

The next extension will be the application of hydraulic transport for conveying coal from the working districts to the shaft bottom. The hydro-dynamics of such systems are more complex and, unless precautions are taken and appropriate control devices used, the systems may be inherently unstable and fail by separation of coal in the pipe with consequent blockage. This instability is due to the fact that, for any particular suspension in a pipe of given size, there is a critical velocity above and below which the pressure gradient will rise. If the system is allowed to operate near to or below this minimum velocity and the pump used is not of the instant-flow type, a small disturbance of the system, for example by a variation in the rate of coal feed, may produce instability. Sufficient information is now available to enable the pressure-flow characteristics of all systems, and of separate components in them, to be predicted and to allow control gear to be devised to ensure that stability and economy are simultaneously maintained.

Hydraulic transport of coal could be used not only to transmit coal from the working districts to the shaft bottom and up the shaft to the surface treating plants but direct to the surface *via* vertical boreholes at the working districts. It would be most useful to convey the coal from a number of pits to a central washery and from washeries to power stations and other points of use, thus avoiding the multiple handling of the coal into and out of rail wagons, etc., and overcoming obstacles such as railway lines, buildings and rivers.

A most important advantage which would accrue from the use of hydraulic transport underground would be the great reduction of fire and explosion risks and of the dust raised by conventional methods of coal transport, and financial savings in respect of precautionary measures necessary to counter these hazards.

Initial calculations have shown that hydraulic transport should be much more economic than the normal transport systems now in use underground.

In CHEMICAL & PROCESS ENGINEERING we shall shortly be publishing an article on the hydraulic transportation of coal, which is being specially written for us by Mr. A. T. Steadman, M.INST.F., A.I.MIN.E., G.I.CHEM.E. After reviewing earlier application of hydraulic transportation and discussing present experiments the article will go on to the engineering aspects, etc.

Sulphuric acid from feedwater

WHAT seems to be an unusual method of making sulphuric acid was evolved, unwittingly, at an industrial works where they were not particularly interested in sulphuric acid, and this came about simply because the water fed to a water-cooled, high-frequency electrical furnace was not treated. The instance was recalled at a meeting of the Incorporated Plant Engineers in Sheffield recently, where they were discussing feedwater treatment for boilers, metallurgical and process furnaces, etc., by Mr. James Law, formerly Chief Smoke Abatement Inspector for that area. His account makes amusing reading, although it was an expensive joke for the firm concerned.

At first, the owners of the furnace were putting the water down the sewer, but they found that expensive because it was metered and charged up to them. So they got a local firm to make a fully-contained circulation system whereby the hot water was returned, passed over a fan, cooled and used over and over again. It worked very successfully for about three years and then one morning they started up the pump and nothing happened. They opened it up and found that the insides of the pump had disappeared altogether. They tried to blame the local chemical works for it, but when they came to examine the water, it was found that, as they had not thought to use any soda ash or anything to neutralise it, it was concentrated sulphuric acid.

Comical Engineering Terms

"PACKED COLUMNS"

What had happened was that the hot water coming up from the water jacket of the electric furnace was blowing on to the fan, the fan was blowing air which contained an amount of sulphur and the hot water absorbed the sulphur until it gradually concentrated and took the whole of the interior of the pump away.

New light on feedwater treatment

DESPITE the foregoing incident, and where boilers of any sort are concerned, there seems to be a general awareness today of the need for effective feedwater treatment. And this brings us on to an article which will appear in CHEMICAL & PROCESS ENGINEERING next month and which should prove of great interest to chemical plant and power station engineers. It will be written by S. R. M. Ellis, PH.D., F.R.I.C., A.M.I.CHEM.E. Dr. Ellis, our readers will recall, was the co-author, with Mr. J. T. Shelton, of an extremely interesting contribution on 'Batch *versus* Continuous Distillation' which we published some time ago. In our March issue, he will survey some aspects of boiler feedwater treatment, dealing, *inter alia*, with ion-exchange processes, corrosion problems and the use of hydrazine as an oxygen scavenger. The article will include some of the latest information on feedwater treatment, together with some new data.

Lithium expansion

PLANS for the construction of a big new plant for the manufacture of lithium chemicals near San Antonio, Texas, are a sign that the range of applications for this alkali metal, apart from nuclear reactions, is widening. In Southern Rhodesia the firm of Bikita Minerals Ltd., now sharing in the new venture with American Potash & Chemical Corporation, has been producing high-grade lithium ores like lepidolite for the heat-resisting glass industry as well as for other markets. While the metal itself has been developed by the Lithium Corporation of America for maintaining inert furnace atmospheres, an application in which the very high affinity for oxygen is the decisive factor, much lithium goes into lithium-calcium alloys for copper purification, lithium stainless steels, lithium-hardened bearing alloys, and into various aluminium, zinc and magnesium alloys, and silver solders.

On the chemical side a number of applications include lithium hydride and borohydride for portable hydrogen, lithium hydroxide in alkaline accumulators including cadmium, lithium chloride as a 65% solution for efficient dehumidifying in the air-conditioning field, and uses in the ceramic industry in fluxing, vitrification and bonding.

The U.S. is the largest producer and user of lithium, and there are four major producing concerns. One of these is the Lithium Corporation, already mentioned, which is just completing a new $7-million plant at Bessemer City, North Carolina. American Potash & Chemical Corporation has produced lithium chemicals at its plant at Trona, California, since 1934, with all of the Trona output since 1951 being in the form of lithium carbonate. In addition, the company has been marketing lepidolite, a high-grade lithium ore, from Bikita since the latter part of 1953. The firm hope to start construction of the San Antonio plant early in March and complete it by the end of the year.

A third lithium producer, Foote Mineral Co., recently increased its rate of production, and finally there is Maywood Chemical Works, a smaller producer that for many years has been supplying lithium hydroxide for Edison batteries.

From the United Kingdom, close upon the announcement of the American Potash & Chemical plans, comes an indication that Borax Consolidated is getting ready to exploit its lithium deposits in the shales of its mine in California, believed to be among the largest deposits of lithium in the world. What is thought to be an economic method of extraction has been evolved and plans for a pilot plant are being prepared.

Highlights of lithium's history

THE new lithium chemicals development comes appropriately on what may be called the true centenary of lithium metal. Although Arfwedson, one-time student of Berzelius, 'discovered' lithium in 1818 after he had been put to study petalite by his Swedish teacher, this very skilful chemist never succeeded in isolating a single bead of the free metal.

So it had to be Humphry Davy, father of alkali metals, who added one more to his score in this inspired period. Davy, ' full of the odium of discovering sodium,' as a wit put it, was in his heyday, triumphing so surely with alkali metals that, when the news reached Paris, Napoleon in his chagrin had constructed an enormous electric pile nearly 100-ft. long, an amazing affair of lead siphons, barrels and pipes holding the acid. Yet the French chemists benefited nothing from this, nor did Gmelin and Arfwedson succeed with lithium. Davy shares the isolation of a few beads of ' brilliant white and highly combustible lithium ' with Brande, the other British chemist in the early story.

It was only in 1855 that lithium metal was separated in sufficient quantities for a thorough study of all its properties to be undertaken. The immortal Bunsen was the dominant figure, with Matthieson as his collaborator. Bunsen not only invented his famous burner, flame tests with which showed carmine-red lithium so well, but later brought in the spectroscope, which he invented with Kirchoff, to clinch this mode of detection. But since Bunsen was a first-rate physicist, what more appropriate than his use of six Bunsen cells in place of the inefficient voltaic pile of Berzelius for decomposing fused lithium chloride, to yield the metal which he scooped out with an iron spoon and placed below petroleum.

Lithium history is full of such highlights. Lithia for pharmacy had its beginnings when Berzelius found it in spa waters of Karlsbad and elsewhere, and with Bunsen finding 295 mg. lithia per litre in a Baden-Baden spring. Yet even this was surpassed in Davy's own county, the spring waters of Wheal Clifford mine near Redruth, Cornwall, yielding a record 372 mg.

Spray drying a 60%-solids slurry

AN economical process entailing the spray drying of a slurry containing 60% solids is being used by the Minerals & Chemicals Corporation of America. A dispersant—tetrasodium pyrophosphate—is used to turn a filter cake with a high solids content (containing aluminium silicate pigment) into a free-flowing slurry.

Here, as in most developments of this kind, necessity proved the mother of invention, for spray drying was the only method open to the company for producing aluminium silicate pigment of satisfactory particle size and shape, and some way had to be found of cutting the high cost of the operation. At the company's plant at McIntyre, Georgia, mined kaolin is subjected to various operations and eventually a washed cake with a solids content of 58 to 60% passes from the rotary vacuum filter to a mixing vat. It is at this point that the tetrasodium pyrophosphate is added. The resultant slurry goes through a screen and liquid magnetic filter and then enters the 29½-ft.-diameter, stainless-steel spray drier.

According to the January issue of *Chemical Engineering*, in which a brief description appears, the chief advantages of the innovation are increased solids throughput, low fuel cost and a greatly improved product.

Acid corrosion and velocity of flow

SULPHURIC acid is used under a variety of conditions in the chemical and petroleum industries and, to guide him in his choice of materials for the job, the chemical engineer is dependent on the results of laboratory research as well as practical experience. In the laboratory it has been usual to carry out tests with sulphuric acid of different concentrations and temperatures under static conditions. But the data thus obtained are inadequate for a critical choice of materials, as the corrosion rate is influenced by numerous other factors as well. In the corrosion of pumps and pipelines, for instance, the velocity of flow plays an important part.

At the corrosion congress which was organised in Frankfurt recently by Dechema—the German Chemical Plant Manufacturers' Association—a laboratory method which permits measurement of corrosion under different flow conditions was described by H. W. van der Hoevan of Holland. As in the earlier static tests, the effect of corrosion was investigated as a function of the time during which the attacking liquid is in contact with the metal (a period which may vary between several hours and several weeks). Also investigated was the influence of other factors, such as the accumulation of corrosion products in the attacking liquid. The discussion included the results of measurements on carbon steel and aluminium/nickel bronze, carried out by this method.

Cement plant ordered by postcard

A POSTCARD seems a somewhat inadequate document with which to clinch a contract for a cement plant running into hundreds of thousands of pounds. Yet, on one occasion, and in the days when postcards could be sent for as little as a halfpenny stamp, a well-known firm received such an order by this means.

The story begins when, sorting out his morning mail, an executive of the firm came across a postcard asking for a quotation for a complete cement plant to be erected in Australia. His first thoughts about this were that an enquirer who was not prepared to spend more than a halfpenny on his inquiry was unlikely to have the funds to finance the purchase and erection of a cement plant. Nevertheless, he was intrigued with the brevity of the communication. The details were gone into, and a tender was got out.

In due course, steamship mail brought a reply. It was again on a postcard, and contained the acceptance of the tender. Not unnaturally, the tendering firm considered it necessary to make some enquiries regarding this thrifty client. Contrary to expectations, however, the reputation of the firm concerned proved good, and eventually the order was accepted, the contract executed, and as far as is known the plant is still functioning today.

As is pointed out in the January issue of *Edgar Allen News*, in which this curious fragment of the firm's history is recorded, there can be few other instances in which so big a contract has been placed by postcard.

The Chemical Engineer as a 'TROUBLE SHOOTER'

By F. Roberts, B.SC., A.M.I.CHEM.E.
*(Atomic Energy Research Establishment, Harwell)**

As well as his function as designer, research worker or executive, the chemical engineer can fulfil a most valuable function in the process and chemical industries as a 'trouble shooter'—sorting out troubles on large-scale plants and so helping to reduce production costs, remove bottlenecks and increase throughput. In this article the author surveys the 'trouble shooter's' field of operations and discusses, with some interesting examples, the sort of problems encountered in the process industries and in three main types of chemical works.

THE chemical engineer may function as a trouble shooter while acting in any one of three capacities: as plant manager, as member of a development section under the direct control of the production or works manager, or while working in a research department controlled independently from the production department.

As plant manager, he enjoys the advantage of being in direct control of the plant and has the allegiance of the plant staff and labour force; however, he is frequently in the difficult position of not being able to look at the process objectively, because he lives with it and tends to take too much for granted. This latter difficulty does not arise when research department staff are called in, but, without the complete confidence and honest co-operation of production staffs, their efforts are bound to fail. Co-operation is brought about by the works manager creating the right atmosphere, and by the consultant exercising great tact and patience and ultimately proving his skill by his results. He should be given access to all plant records, and allowed to talk freely with all personnel connected with the particular plant or process which is under consideration. The technique of the chemical engineer may lead him to request certain modifications in the production schedule which may mean a reduced output for a brief period, but such requests should be considered sympathetically by the works management.

In this article, it is generally assumed that the chemical engineer is called in as a specialist, and is not the plant manager of the process being studied.

A 'process industry' is considered to be one in which one or more physical (or even chemical) changes take place without the production of 'chemicals' (as used in the commercial sense) as the end point. Examples include sugar refining, laundering, brewing, dyeing, paper making, tanning, and the metal-handling industries. There are hundreds of small firms which normally obtain no direct help from a person experienced in chemical engineering methods. Although research associations often exist to cover these various industries, the result of their work is not always directly applicable to the problems of an old-established works; their programmes of research are often directed toward long-term objectives.

Trouble shooting in the process industries

It is becoming clear that the chemical engineer is a valuable asset in the process industries as well as in the chemical industry, a fact well established in the U.S.A. After a careful survey of the plant and an overall study of the process, a chemical engineer can often sort out bottlenecks, save materials and reduce servicing costs. Many small processing works have a laboratory, a power plant, a water-softening plant and an effluent treatment unit. Here indeed are fields for the direct application of chemical engineering methods.

In the process itself the existing methods of sampling may be unsound. If the samples are not representative, then the efforts of the laboratory staff are of no avail. A sound review of sampling systems, and an exhaustive inspection of analytical records by the consultant is often well repaid. Attempts to correlate records are often successful to a greater or lesser degree.

In one case, a certain process variable was stated to be running at too high a level; it was claimed that it had been slowly rising for many months. Extensive study of back records revealed that the gradual rise was a seasonal one, but that at some date a *sudden* increment had occurred, thus raising the absolute level of the variable. Further investigation soon related the sudden rise to a change of management, accompanied by a change in processing. (A reversion to the original processing method produced results which soon convinced the new management.)

Passing along to the power house, one usually finds scope for saving fuel. Many of the problems have been exhaustively described in the Ministry of Fuel and Power bulletins, published from about 1942 onwards. In these bulletins, the solid fuel problem was often considered as an integrated whole with the overall steam and electric power requirements of the works. This fundamental approach to one of industry's special problems was sound and could be more widely used in solving processing problems in general.

Pumping troubles

Many difficulties in process works have been traced to pumping troubles. The chemical engineer who would be a trouble shooter would do well to make himself an expert on pumps and their characteristics and he should be very adept in applying the laws of hydraulics in a practical way. Most pumping troubles, in the writer's experience, have been due to the application of the wrong pump to a particular duty. This may have been due to a change in the scale of operations or the method of working the process *after* the installation of a given pump. Or, again, a spare pump found

*The views expressed in this article are those of the author.

'lying about' the works may have been pressed into service for a duty for which it was never designed. The makers will always furnish diagrams giving the characteristics of any of their pumps, and these should be consulted, after the static head, total head, speed and throughput rates have been measured for any part of the process where pumping is necessary. It is in the chemical engineer's province to *select* a pump, but the mechanical engineer's job to *maintain* it in a sound state of efficiency.

The pump should not be blamed as inefficient or worn, when the trouble is due to increased pressure drop in a sealed pipeline. A few measurements with a pressure gauge can save a lot of time in useless stripping of pumps for examination.

Certain plants which originally involved the lifting of slurries in bucket elevators have been improved by the installation of centrifugal-type slurry pumps.

Three types of chemical plants

The types of problems referred to above are also found in the chemical industry proper. The character of chemical works has gradually changed over the last 60 years or so. This is perhaps due in large measure to the rapid advances made in instrument technology during this century. Three main types of chemical plants have evolved and, in chronological order, these are:

(*a*) Batch processes. Very little instrumentation initially, but more nowadays.

(*b*) Continuous processes with indicating and recording instruments, controlled manually, the only controllers being perhaps on steam, electricity or compressed-air services.

(*c*) Continuous processes with automatic control. The era of the recorder-controller.

Present trends in the development of industrial electronics, with the introduction of the computor, may lead to type (*d*), the robot-controlled plant, which automatically adjusts itself to give optimum conditions of production. However, at present, the chemical engineer is much in demand to deal with the troubles encountered in types (*a*), (*b*) and (*c*).

Batch process problems

The type of plant where each batch passes successively through a series of stages or vessels is usually arranged with production lines built in pairs. It is advisable to cross-connect where reasonably possible, in order to be able to by-pass vessels when mechanical breakdowns occur, or when a given batch is held up at some particular stage pending analytical investigation. When called in to deal with troubles on old-established plants, the chemical engineer should first ascertain the original *designed* capacity of each unit. It may frequently be found that the present batch size or processing cycle is unsuited to the size of plant in use. For example, the author once found that a plate-and-frame filter press which was giving an inadequately washed cake was operating on half the original batch volume. On reducing the number of plates and frames, a good washed cake which filled the whole of every frame was obtained and satisfactory operation was rapidly established.

Again, troubles have occurred on several occasions in the past due to the overloading of tray driers. The author was called in to find out why a particular product had deteriorated in quality after output rates had been increased. It was found that one of the ingredients had an abnormally high moisture content, owing to the fact that the wet feed material to the tray drier had been packed to a greater depth on the original number of trays. When process operators are told to increase the throughput, they should also be instructed as to the number of trays which must be brought into use in order to maintain a constant bed depth.

Batch process problems have even arisen when plant was being operated at its designed capacity. Here it cannot be emphasised too often that, where a flowsheet has been laid down, the plant manager must adhere to it, unless he has the proper authority to make a change. The author has more than once been called in by works managements to solve production problems, when the real key to the difficulties was that the local supervisor had altered his processing schedule for some private reason. If plant process records are not accurately and clearly made this kind of problem can involve the 'trouble shooter' in a considerable amount of effort in sorting things out.

Some interesting problems arose once in connection with a process where an expensive solution was being purified by successive washes with a series of immiscible liquids. Unfortunately, there was little provision for measuring the quantity of the valuable product lost in the washes, and the input and output figures were the only consistent records available. The 'efficiency' of the process, E, was measured thus:

$$E = \frac{100 \times \text{quantity of product remaining after purification}}{\text{Input of product to process}} \%$$

The production management were disturbed because wide fluctuations in E had occurred. The reason for this was not difficult to see. Suppose a true batch efficiency was 98%, with 2% of the valuable commodity being lost in the washes. Then, if input and output are each measured with a precision of $\pm 5\%$, the value obtained for E will fall anywhere between about 90 and 108%. It was only necessary to determine the amount of product lost in the washes, even with an error of 20%, to get a much more accurate measurement of the batch efficiency. This stresses the need for fairly accurate mass balancing.

The true efficiency was even further obscured by the fact that it was not possible to empty the process vessels completely, a 'heel' of liquid being left behind each time; this resulted in each batch being contaminated with some of the previous one, and a little of the mixture was again left behind. It was possible for the actual volume of the 'heel' to vary, depending upon the way the operator emptied the vessel. In many chemical processes, it is not advisable to fit a container with a bottom run-off and, under these conditions, the problem of 'heels' always applies; for a suction tube must be inserted into the vessel or alternatively some form of air-lift tube, such arrangements usually resulting in 'heel' formation due to incomplete discharge of the contents. (In the case of the suction tube, vortex formation is likely to occur and, in both cases, the liquid in the lift tube is likely to run back when the off-take syphon breaks.) In continuous processes, the problem of 'heels' is largely eliminated.

Continuous processes without automatic control

The chemical engineering consultant is frequently asked to suggest ways and means of increasing production from an old continuous plant. The difficulty is twofold, because the time taken up by maintenance shut-downs is steadily increasing with old plants, and yet the unit is required to exceed its designed overload capacity. The real answer is to build a new plant, but under present industrial conditions it may take about four years, depending on its size, to complete a new

project, especially if this involves new civil construction work. In the meantime, one has to make do with the existing unit.

It was required on one occasion to increase the output of a triple-effect evaporation unit by about 20%. The set was already working to capacity. Throughput was increased by running Nos. 1 and 3 effects as a separate double-effect unit, and No. 2 effect was operated as a single-effect unit in parallel. This served to increase the heat input to the calandrias by increasing the respective temperature differences across the tubes. It was appreciated that steam economy was being sacrified to a large extent, but it was more important to achieve output. Further difficulties then ensued owing to the increased salting rate in the calandrias, which tended to result in the large-scale blocking of tubes, thus necessitating lengthy shut-down periods. The steam input to the calandrias had then to be throttled back until a nice balance was obtained.

Plants become obsolete when a new process is discovered which can yield a cheaper product. Sometimes a growing demand for a particular product necessitates the operation of both old and new plants side by side. However, owing to the high capital costs of new plant, amortisation charges are necessarily high, and this adds to the works cost of the product. In the case of old plants, the capital cost has usually been recovered and therefore it is sometimes possible to produce the commodity at a competitive charge. The rising cost of maintenance eventually results in the old plant being shut down and dismantled in order to yield valuable space in the works. It is always necessary whilst working on such plants to keep quite clear the relative importance of output and operating costs.

In a continuous process, one of the outgoing streams is often rich in unchanged feed material and this is usually recycled to the beginning of the process, where it becomes mixed with fresh raw material. Most process managers take considerable care to maintain quality control of all raw materials, but sometimes fail to keep sufficient watch on the nature of any recycled material. Troubles have arisen when the moisture content of recycle material has been allowed to increase. Conveyors are designed to handle a feed with a certain moisture content; no matter how dry the raw feed might be, an overwet recycle portion can cause extensive clogging of conveyors and elevators. This leads in the case of bucket elevators to a reduction in their capacity, owing to the steady build-up of a compacted layer in each individual unit. Extensive clogging of elevator boots and delivery chutes can easily lead to mechanical breakdown. The answer is to provide for frequent sampling and analysis of the recycle material. Again, any increase in the level of impurities in the recycle portion must be detected immediately; failure to do so has often resulted in large quantities of the final product being outside the specification limits, and large quantities may have accumulated before the laboratory analysis of samples of a consignment has revealed a defect.

When some stage of a continuous chemical process goes wrong, supervising personnel commonly take many samples and send them to the laboratory to be analysed for almost all the elements in the periodic table. Samples should be taken by all means, but it is a sound plan to check whether any physical explanation can be found for the trouble. For example, in a high-temperature process, some change in the plant heat balance may lead to the formation of a sludge that does not normally arise.

This is perhaps a suitable place to stress the importance of the trouble shooter becoming heat-balance as well as mass-balance conscious, for heat is equivalent to money. In any process where extensive heat or energy changes take place, a careful energy balance should be drawn up on paper and studied carefully alongside the mass flowsheet as a preliminary to investigating any particular production difficulties. When trouble arises on a chemical plant, how frequently somebody notices a sludge which was ' never there before,' and how often does the laboratory say that this sludge contains iron, silica, carbonaceous matter and traces of a whole host of elements which are present as normal impurities in the raw feed materials! Analytical services are very costly today, and should be used shrewdly and economically.

The problem of *short-circuiting* should be mentioned. This is most likely to arise when a batch process is being converted to continuous operation. Although continuity has its advantages in reducing labour costs, giving simplicity of control and a more uniform product, it is not always remembered that this may result in a decreased capacity per unit volume of equipment. For the condition of continuous feed and continuous discharge in a single unit, there does not exist any means whereby a uniform retention time within a reaction tank for all portions of the feed is assured; the outgoing stream will always be made up of portions which have stayed for various periods of time in the system. This phenomenon should be carefully considered in conjunction with the chemical kinetics of the particular reaction being carried out. If mixing conditions are far from ideal, the problem is even more acute.

Automatically controlled continuous processes

Many of these very modern plants are to be found in the petroleum refining and allied industries. The equipment is frequently on a large scale, standing in the open, and supported by a steel framework. All recorder-controller lines lead into a control room, built at a strategic point. Inside this room is the control panel, which is the ' brain ' of the whole unit. When things go wrong on such plants, it is no use the trouble shooter trying to solve the problems by merely standing in front of the control panel. He must get out on the plant, and endeavour to learn the main piping layout off by heart. This will probably take several days, but the time spent will be well worthwhile. Although the control panel probably indicates the main layout, it has been found useful on several occasions for the chemical engineer to prepare his own coloured line diagram. It is especially important for him to know the positions of cross-connections and manual shut-off valves.

It may be difficult to find the root of the trouble; there may be a scientific reason which has no apparent connection with the trouble. On one occasion, a large plant for the production of a substance which is normally volatile at room temperatures was shut down owing to abnormally high pressures in the tail gas line. All the valves were open on this line, and the pressure should not have been much above atmospheric. Tests soon indicated a blockage in a gas scrubber installed in the tail gas line. The blockage was due to the freezing up of the scrubbing liquor in the packing, although the ambient temperature was over 20°C. Several minutes' application of steam from hoses to the outside of the tower melted the ice and allowed the plant to be started up. Later, investigation showed that somebody had opened a cross-connection which had allowed several gallons of the volatile product to escape into the tail gas scrubber. The freezing of the scrubber water was produced by the withdrawal

of heat as latent heat of evaporation.

Provided that the instruments maintain their efficiency, these types of plant should not involve the chemical engineer in any special problem during normal running other than those encountered with continuous processes without automatic control. A good instrument man is worth his weight in gold, especially during the commissioning period, or after plant modifications have been carried out. (Although process operator costs may be very low on this type of plant, compared with the other groups, instrument artificer charges will probably be the heaviest.) If the chemical engineer is likely to be concerned with this type of plant to any great extent, he would be well advised to make a special study of instrumentation. There are a number of good part-time courses or series of lectures on the subject which can be recommended.

Conclusion

Having surveyed some of the various types of problems which the chemical engineer is likely to encounter in his career as a trouble shooter, it will perhaps be useful to conclude by stressing the most important points to which he should devote his attention while building up his experience:

(1) He must above all develop the knack of getting on well with all types of people, even helping a workman with a dirty job for a few hours. The writer well remembers gaining the devoted attention of a boiler fireman to matters of fuel economy by handling the stokehold tools alongside him and assisting him to burn low-quality fuels in his furnaces. Above all, he must learn not to transgress the niceties of trade union ethics. When dealing with foremen and chargehands the specialist should always explain the technical plan of campaign, and give some indication of the underlying theory. They may not understand completely, but they will be flattered at being taken into the confidence of the expert and will co-operate loyally with him.

(2) It has been emphasised previously how important it is to be 'flowsheet, mass-balance and heat-balance minded.'

(3) The chemical engineering trouble shooter must learn how to extemporise ways and means of obtaining data on the plant. To do this, he must be able to weigh up the likely errors in employing a rough-and-ready means of measuring a quantity, and then make a decision as to whether the data is worthwhile obtaining at the level of accuracy. For example, he may be able to obtain the evaporation load on a shell-type boiler by turning off the water feed and timing the rate of fall of the water level in the gauge glass. This rough-and-ready method will probably yield the steam load accurately enough for assessing whether a boiler is overloaded, but obviously would not be satisfactory for measuring hour-to-hour evaporation rates on a routine basis. Again, suppose it is desired to estimate the load on a rotary vacuum pump at different pressure drops. It is easy to fit up a manometer for pressure measurements, and the quantity of exhausted air can be measured by fitting a simple velometer into a cardboard shroud and holding it on the delivery outlet; of course, this may be 30 ft. up in the air!

(4) He must become expert in the direct application of Bernoulli's theorem to all varieties of practical fluid handling and movement problems.

(5) The significance of errors and the rational planning of experiments must be studied. The chemical engineer should become a student of operational research methods and apply this in a qualitative sense when trouble shooting.

(6) It is extremely valuable experience for a chemical engineer to take responsibility for running a production unit for a year or two. Only thus will he really be able to understand the viewpoint of the production executive when he is called in to help as consultant later in his career. It is necessary to get the *feel* of chemical plant operation, a faculty which is well understood among 'plant men.'

Pulsed Columns and Cavitation

THE height of a packed column used for liquid-liquid extraction can be greatly reduced if the liquid phases in the column are 'pulsed' or agitated with a reciprocating motion which increases the dispersion of the disperse phase and results in improved mass transfer.

Van Dijk's original unpacked column had close-fitting plates which could be moved up and down, thus increasing the agitation; alternatively the plates were stationary and the liquid was reciprocated by means of an external piston and cylinder.

Various workers have experimented with both plate and pulsed columns. Some have used plate columns successfully; others have not.

The action of pulsing can generate large pressures which, at high frequencies, result in 'cavitation,' and the system is made inoperable because of bubble formation in the line from the column to the pulse generator.

In a paper presented to the North Western Branch of the Institution of Chemical Engineers recently it was shown how the pressures developed in a pulsed packed column could be calculated and the point at which cavitation will occur predicted from this. The authors of the paper were J. A. Williams, B.SC., A.M.I.CHEM.E., and D. J. Little, of the United Kingdom Atomic Energy Authority, Industrial Group.

They pointed out that the pressure wave developed by the pulsing of a column is the resultant of two components, one due to the frictional resistance of the system and the other due to the inertial resistance of the system. The total pressure exerted by the prime mover on the liquid may be evaluated at any instant by the algebraic summation of the instantaneous values of the two components plus the static head of liquid at the prime mover, *i.e.*

$$P_p - [(H + P) + KV^2 + Lf/g] = O$$

In this equation P_p is the total pressure, $(H + P)$ represents the pressure exerted by the static head at the prime mover plus atmospheric pressure, KV^2 is the friction term and Lf/g the inertia term.

In experimental work, a column was erected with a total length of 55 ft. of 1½-in.-bore stainless-steel pipe, in the shape of a U tube, one limb of which was packed with 25 ft. of ¼-in. stainless-steel Lessing rings. The prime mover was an E.C.D. pump of 2-in.-diam. piston and a maximum stroke of 0.446 in.

Pressures developed were measured by means of a capacitance gauge. The variation in capacity with pressure was transformed into a voltage signal by means of a high-frequency oscillator and detector unit. The signal was amplified and shown as a trace on a cathode ray tube. The instrument was fitted with a camera and a time base so that a record of the wave form could be taken.

The calculated values were compared with those measured on the column and it was concluded that reasonably accurate results could be obtained using this method.

DIRECT-FIRED HEATERS IN THE CHEMICAL INDUSTRY

By R. Olley, M.C., B.SC., A.M.I.CHEM.E.
(Head Wrightson Processes Ltd.)

The uses of direct-fired heat-transfer equipment range from providing the heat for distillation to heating fuel oil in large quantities; they cover such diverse applications as superheating hydrocarbon gases for driving gas turbines, and preheating gases for chemical processes. The author considers some heating problems, describes various types of direct-fired heaters available and touches on the controversial subject of 'headers.' Finally he gives some pointers to intending purchasers of direct-fired equipment.

IT is not uncommon in the chemical industry to think only of steam for heating liquids. The two old sheet anchors, the jacketed pan and the heat exchanger, are often the only methods considered if direct injection of steam is not used. Frequently the temperatures required in the liquid to be heated are too high for the convenient use of steam, and alternative methods must be adopted.

Liquids were first heated in a chemical process for cooking and the technique then used was, almost certainly, the dropping of hot stones into the brew. This method was called 'stone boiling' and existed until quite recently. However, most people came to realise that food could be cooked more easily by putting a pot on the fire, and the lesson that water could be boiled in this manner has been widely appreciated. Unfortunately, not every one is aware that other liquids can be treated in the same way with safety and economy.

There are, of course, perfectly good reasons why people think first of steam. Nearly every works has a steam plant, and steam-generating equipment is highly developed and very familiar. In addition, many of the earlier attempts to heat some liquids directly were not notably satisfactory. The foregoing must exclude those industries where direct-fired evaporating pans are widely used for dehydrating or fusing inorganic materials, and also one very important 'liquid' industry —the petroleum industry.

It is intended to put forward some of the factors involved in the use of direct heating for fluids other than water and to suggest the occasions when it should be considered. This includes times when it is desirable to interpose a heating medium, such as a heat-transfer oil, between the source of heat and the fluid to be heated.

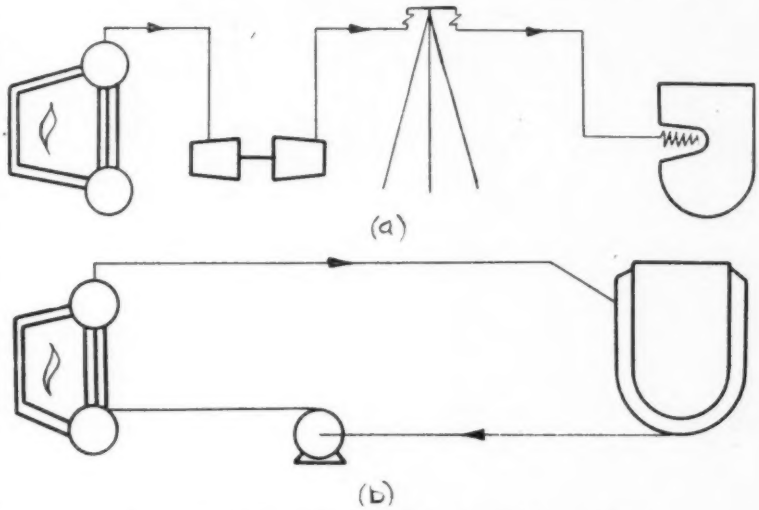


Fig. 1. Heating by (*a*) electricity; (*b*) transfer medium.

Direct v. indirect heating

Every time an extra piece of equipment is introduced into a chain of operations the efficiency falls and, generally, the overall cost of the operation goes up. At the moment nearly all heat for process work must be obtained by burning a fuel, and the object is to convert the heat of combustion as economically as possible into useful heat.

Some of the basic ways of doing this are shown roughly in Fig. 1. The diagram (*a*) illustrates heating by electricity and shows firstly the boiler, then the turbine and the generator, and lastly the transmission. This is an expensive means of supplying heat and the consumer is obliged to pay for all the equipment used, but there are cases where it is the best method and sometimes the only method of providing heat where it is wanted.

Fig. 1 (*b*) illustrates a system where no change takes place in the form of the energy used, heat transfer being achieved through some medium which may be water. When the temperature of the fluid to be heated is above 300 to 350°F., water is not the most economical medium. This is largely because of the higher pressures involved. If, for instance, it is required to heat a liquid to 350°F. in equipment of a reasonable size, a steam temperature of 400°F. would not be an excessive requirement. This means operating at about 250 p.s.i.a., which is costly and, to avoid excessive loss of heat, the condensate must either be pumped back to the boiler at or near this pressure or additional uses must be found for the sensible heat in the

water, necessitating the installation of still further equipment. The following situation would arise if the condensate was returned to the boiler at 30° below atmospheric boiling point, *i.e.* 182°F., and use ordinary pumps from an open hot well (values rounded off):

	B.Th.U./lb.
Total heat in steam delivered to point of use	1,201
Heat used, *i.e.* given up in condensation	825
Heat returned to boiler in water	150
Heat put into water by boiler	1,051
	%
Efficiency of utilisation of this heat	78.5
Assume efficiency of boiler plant (net) at operation conditions..	75
Overall efficiency of system	55

No account is taken in this example of losses in lines or from equipment, nor of the higher price of equipment suitable for operating at this pressure. It is also true to say that an average efficiency of 75% on a works boiler plant, particularly a small one, is exceptionally good.

This should be compared with a system using either a special heat-transfer fluid, which may or may not be used as a vapour, or an oil specially treated for the purpose. The heat-transfer oils sold by the major oil companies are good for bulk temperatures of 600°F. when used in properly designed equipment. There are variations in these oils, but this is a general figure. At this temperature these oils are used at atmospheric pressure, plus whatever static head there is in the system. The special heat-transfer fluids, in some cases, work at even higher temperatures.

There is a further consideration. If the previous example is taken and assuming that the overall heat-transfer coefficient to the liquid is 200 B.Th.U./hr./sq.ft.°F. and that the resistance due on the steam side can be neglected (which it cannot), then, if in an oil system the oil heat-transfer coefficient is 200 B.Th.U./hr./sq.ft.°F., giving an overall coefficient of 100 B.Th.U./hr./sq.ft.°F., the relative size of the exchange surface required would be for steam

$$\frac{1}{50 \times 200} \quad \text{against oil} \quad \frac{1}{200 \times 100}$$

(assume average oil temperature, 550°F.). Not only is the exchange surface required more expensive per sq. ft. for the steam system, by virtue of the pressure, but twice as much is required. Alternatively, from a given piece of equipment it may be possible to get twice the work in the same time,

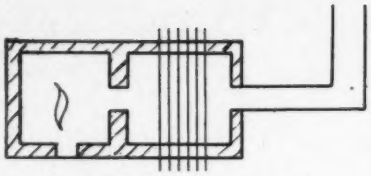


Fig. 2. Convection heater.

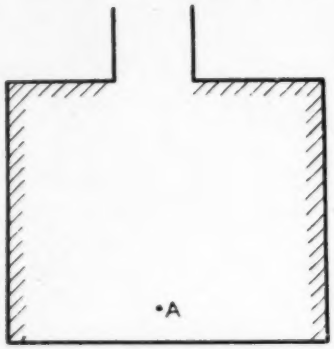


Fig. 3. Heat absorption surfaces of radiant section of a heater.

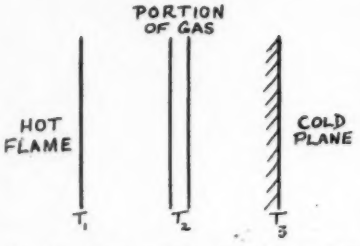


Fig. 4. Heat passes through the gas to the cold plane.

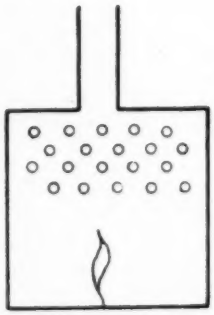


Fig. 5. 'All convection' heater.

provided that the initial source of heat is large enough. The overall efficiency of direct-fired heaters should range from about 60% for small units upwards, the size of the system effecting the degree of elaboration justified. The efficiency of transmission of the heat to the point of usage obviously depends on the care taken to lag lines, etc., in exactly the same way as in the case of steam lines.

Clearly, in those cases where it is required to heat liquids to high temperatures, the possibility of using heat-transfer fluids should be carefully examined. It is the writer's opinion that the simplest system, that of heating the fluid directly, would more frequently be adopted if it were brought to the notice of operators, and the advantages and pitfalls clearly explained. This holds good even in cases where only low temperatures are required. It is well worth while considering direct heating for heat quantities from $\frac{3}{4}$ million B.Th.U./hr. upwards. There are frequently very good reasons why direct heating cannot be used; nevertheless, the arguments put forward against direct heating in many cases are fallacious and arise from either a lack of understanding or from adherence to tradition. Each case should be examined strictly on its merits.

Convection and radiation

In order to make some assessment of the problems, it is necessary to examine the type of heater available for the work. The first type of heater was the directly fired pot and, in some cases, it still has its uses. Certain drawbacks were found to this method when it came to heating viscous or inflammable liquids. Firstly, there must be no flame contact (except in special cases), as hot spots might develop; secondly, with viscous fluids the heat-transfer rates on the liquid side were frequently low and uncertain, giving rise to cracking of the liquid, formation of coke, discoloration of product and similar unwanted conditions; and, thirdly, there was a great danger of fire during handling. With the introduction of the tube-still a curious misconception arose and it was thought that, to avoid overheating of organic liquids, such as oil, a convection heater should be used, and so heaters were built something like a shell and tube exchanger as illustrated in Fig. 2.

The heater would consist of a combustion space separated from the heat-absorbing tubes by a partial wall. The exact arrangement of the tubes relative to the fire varied, but the principle remained the same. Combustion being complete in the combustion space, the gases passed through an opening and were then supposed to transfer heat by convection only. It is worth while considering, in a general way, just what does happen in such a case; to go through the complete examination is a lengthy process and beyond the scope of this article, but it can be simplified as follows:

If it is assumed that combustion is complete in the combustion zone and that oil or gas is being burned with a reasonable amount of excess air, say 30 to 40%, under normal conditions, heat is entering the zone at the same rate as it is leaving, thus:

N.C.V. fuel × quantity = sensible heat of gases leaving zone + losses through walls + radiation loss through hole.

Now the temperature of the gases resulting from such combustion would be, if there were no losses, approximately 3,100°F. If we assume 10% of the heat is lost through the walls, this would bring the gas temperature down to 2,800°F.; on a trial balance, including the heat loss through the hole, the wall temperature may be brought down to about 2,300°F., and this wall is radiating to the area of tube exposed. Add this to the radiation from the gases themselves and we can get heat-transfer rates to the tubes facing the combustion zone of over 100,000 B.Th.U./sq.ft./hr. The results of any such heat-transfer rate on an oil may be well imagined.

By using vast quantities of excess air these rates can be reduced to tolerable limits. If the oil side-heat-transfer coefficient were 400 B.Th.U./sq.ft./hr.°F. and the maximum skin temperature the oil would tolerate without cracking were 630°F., then the maximum rate which could be tolerated for a bulk temperature of 600°F. would be 12,000 B.Th.U./sq.ft. requiring several hundred per cent. excess air and very low overall thermal efficiency.

Designs differ and improvements are constantly being made, but it is agreed that the g eater portion of the heat should be transferred by radiation; indeed, many small heaters have no convection section at all.

Heat emission and absorption

When a fuel is fired into a space with heat-absorbing walls and assuming that the radiant section of a heater is represented by the box in Fig. 3, point *A* indicates the spot at which the oil is fired. Heat is absorbed by the walls which are shown hatched, but not by the floor or the two ends of the heater. The products of combustion pass out through the top.

For simplicity we will neglect the differences between gas flames and oil flames, though these are naturally taken into account in the design of heaters, as are the methods of atomising oil and the nature of the particular gas or oil to be fired.

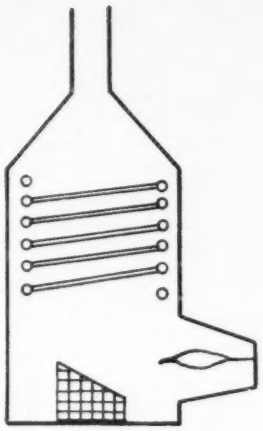


Fig. 6. All-radiant heater for small heat loads.

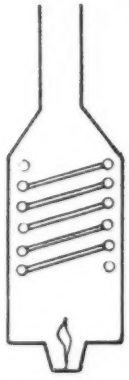


Fig. 7. Cylindrical vertical upshot heater.

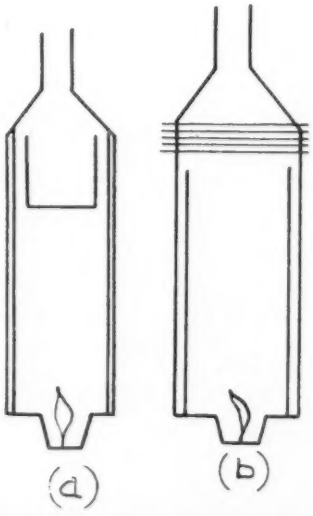


Fig. 8. (*a*) Upshot heater with reflecting cone. (*b*) Upshot heater with convection section.

From the moment the fuel catches fire it starts generating heat and losing heat. The actual period of combustion may be long or short and, because of the coincidence of the evolution and loss of heat, the actual flame temperature falls between the theoretical flame temperature and the temperature of the absorbing wall it must pass through. The absorbing wall is a greater or lesser thickness of gas of the same composition as the products of combustion, and hence the same order of emissivity as these products. (This is not of necessity the same as the flame emissivity, as the latter contains unburnt fuel at high temperature.) Thus an equilibrium is set up between the parts illustrated in Fig. 4. In Fig. 4 the hot flame is radiating heat towards the cold plane and heat is passing through gas in the process. The emissivity of the gas depends on the 'thickness,' composition and temperature.

If the flame is highly emissive and a very thin layer of gas considered, we can write down the balance between them, neglecting convection, in terms of the basic Stefan-Boltzman equation and noting that the heat absorbed by the cold plane must equal the heat lost by the flame thus:

$$\text{Heat given out by flame} = 0.173 \times 10^{-8} C_1 (T_1^4 - T_2^4) + 0.173 \times 10^{-8} C_2 (T_1^4 - T_3^4)$$

$$\text{Heat absorbed by cold plane} = 0.173 \times 10^{-8} C_2 (T_1^4 - T_3^4) + 0.173 \times 10^{-8} C_3 (T_2^4 - T_3^4)$$

where C_1, C_2 and C_3 are factors embracing the emissivity (= absorptivity at the same temperature) of the parts, and their geometry, T_1, T_2 and T_3, are expressed as absolute temperatures. Thus C_1 embraces the emissivity and geometry of the flame and gas, C_2 of the flame and cold plane and C_3 of the gas and cold plane. As in practicable heaters, the surface of the flame is small in the case of high-temperature flames, compared with the cold plane surface, and several feet of gas are interposed between the flame and the cold plane; C_2 is small relative to both C_1 and C_3. With low-temperature flames, C_1 is still smaller than C_2 and C_3 though larger than with small hot flames, and T_1 is approaching T_2. Thus the bulk of the heat transmitted to the cold plane is from the body of the gas in the whole radiant section and not directly from some local flame spot. Therefore, the temperatures in the radiant type of heater never approach theoretical

combustion temperatures as long as the heat fluxes are kept within reasonable limits. In addition, heat fluxes are more evenly distributed, owing to the fact that heat is radiated by each hot particle in all directions equally; not, as is sometimes assumed in a narrow beam, in one direction only.

So true is this that, when high heat fluxes are desired, *e.g.* in order to reduce the area of expensive heat-transfer surface where high-grade alloys are needed, it is necessary to introduce hot refractory surfaces. Referring back to Fig. 3, heat is not only radiated directly to the cold plane but also by the hot gases to the uncooled walls and from them to the cold plane. The ratio of cooled to uncooled surface is another variable at the designer's disposal and is usually written for convenience A_R/A_{CP}.

If it is desired to install a high-efficiency unit, it is desirable to remove the last 20 to 30% of the heat in a convection bank, because radiant-heat transfer rates drop off rapidly as the temperature of the absorbing body and the radiating body approach each other. This is evident from inspection of the equations. In practice it is usual to design all radiant heaters of the type under discussion for between 60 and 65% thermal efficiency, as they otherwise become uneconomically large. Special circumstances may, however, alter this.

To summarise briefly, the advantages of transferring most or all the heat in a radiant section are:

(1) Temperatures are reduced and hot spots eliminated.
(2) Arising from (1) it is frequently possible to substitute high-temperature insulation for refractories except, possibly, where in the event of mal-operation the flame might impinge on the furnace wall.
(3) Also arising from (1) the more even heating means that higher average heat transfer rates and therefore less surface may be installed with safety.
(4) Due to the absence of hot spots coke formation in heat transfer oils and the like is greatly reduced thus reducing the frequency of shut downs and clean outs.

Types of heaters

The foregoing are all fairly well accepted generalities, but it is necessary for those unfamiliar with the different types of heater to have some idea of the types available. Figs. 5 to 10 give those who are not familiar

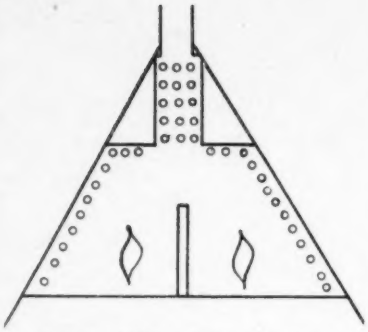


Fig. 9. 'A'-frame-type heater.

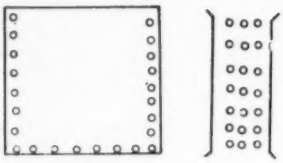


Fig. 10. Radiant section (*left*) and convection section (*right*) of a box-type heater.

with the range of equipment an idea of the basic types which might be of most use in the chemical industry. Users of such equipment in the petroleum industry will recognise all of these types and miss some others which are quite prominent including one, at least, of the most recent developments.

Fig. 5 shows what is sometimes miscalled an 'all convection' heater. In this type the tubes are arranged in a bank above the combustion space and the gases pass up through them. Several variations exist which use baffles, either of refractory or metal, to increase the velocity of the gases over the tubes. A heater of the shape illustrated is miscalled because in fact the first row or two of tubes act also as radiant heat absorbers. From the description given earlier it is evident that if combustion is carried out with what one would regard as a normal quantity of excess air, say 30% for oil or 20% for gas, these two rows of tubes will be subject to great strain as the greatest convection rate of heat transfer is added to a high radiant rate. Such heaters are quite useful when fuel costs nothing and therefore 200 to 300% excess air can be used. This hardly applies in the British Isles.

Fig. 6 shows one type of all-radiant heater which is very useful for small heat loads of the order of 1 to 2 million B.Th.U./hr. This type gives quite good results with low to medium transfer rates when properly designed and worked. The heat-absorbing element consists of a coil through which passes the fluid to be heated. Oil or gas is fired from a combustion 'well' at the side, much of the heat being reflected upwards to the coil from a refractory reflector set in the base. This type of heater is very suitable for fluids which are not too heat sensitive or are well away from any 'cracking' temperature. These heaters are more frequently oil-fired and, depending on circumstances, give efficiencies of 60 to 65%.

Quite the most versatile and generally useful small heater is the cylindrical vertical upshot shown in Fig. 7 with a burner well for oil firing. This type of heater is characterised by its simplicity in operation and evenness of heat distribution. The transfer rates are lower than those of the type shown in Fig. 6, which is of advantage with temperature-sensitive stocks. As a result they are being successfully used in cases where it was previously held that direct firing was impossible.

In some cases the absorbing element in a small heater such as is indicated in Fig. 7 is not a coil but a series of vertical tubes round the wall. This is particularly useful where large volumes of fluid have to be heated but the overall load is small. Gas heating is typical of this type of duty, many gases and vapours being easily heated to high temperatures, particularly when at a pressure of several atmospheres. These units are usually designed for efficiencies of 60 to 65%.

Both the types shown in Figs. 6 and 7, as well as the larger type vertical upshots shown in Figs. 8 (*a*) and 8 (*b*), are steel cased and take up very little ground space. Where duties are larger, and the consequent saving greater, more elaborate forms of heater are justified. For the range 3 to 15 million B.Th.U./hr. probably the most versatile and generally useful type is the vertical upshot with a convection section.

The number of variations in design is somewhat greater than the number of designers but fundamentally most are familiar to one or other of the forms indicated in Figs. 8 (*a*) and (*b*). In Fig. 8 (*a*) the flow of the gases resulting from combustion is constricted to increase velocity, and hence the convection rate, at the top of the vertical tubes. This section is sometimes finned to give more surface. Reflecting cones are frequently hung from the top of the heater to even out and increase the transfer rates over the length of the tubes in the radiant section. The most up-to-date method is to make this construction of metal and so 'transparent' to radiate heat giv-

ing even heating along the full length of the tubes.

The other major variation is to put a convection bank across the top of the heater, as in Fig. 8 (*b*). This is the obvious course, but it is clumsy, relatively expensive and costly in pressure drop through the unit. It is, however, of advantage when two or more fluids have to be heated in the same unit. The cylindrical vertical upshot heater, particularly the type shown in Fig. 8 (*a*), is noted for even heating and ease of control. The figure 15 million B.Th.U./hr. should by no means be taken as the upper limit of usefulness, as very much larger units are successfully operated.

Heaters of this type should, under natural draught, give efficiencies of 70 to 75% or more. When designed for forced-draught firing, even higher efficiencies may be obtained, if paid for by the use of air heating. The limit without air pre-heating is usually determined by the temperature of the feed stock in the type shown in Fig. 8 (*b*) and by the top fluid temperature in the type shown in Fig. 8 (*a*).

When the quantity of heat to be transferred is considerable it is normal to use either what is called an 'A' frame heater (Fig. 9) or a box-type heater (Fig. 10). The 'A' frame arrangement makes an admirable and easily controlled heater, probably finding its chief uses from 20 million B.Th.U./hr. upwards, though it often has advantages in smaller units.

As will be seen in Fig. 9, the heater in this case is built in an 'A' frame with the lower section making a radiant section with tubes round the sides and top. If need be, tubes can be placed over the floor and up the centre wall. Over the radiant section is a conventional convection section which usually runs the full length of the heater. This is an extremely flexible arrangement. The centre wall may or may not be put in. If installed, it may be used to increase the A_R/A_{CP} ratio or to split the heater so that two distinct streams may be heated in the same unit. This type of unit is very readily controlled and will give efficiencies of 75% and upwards on natural draught,

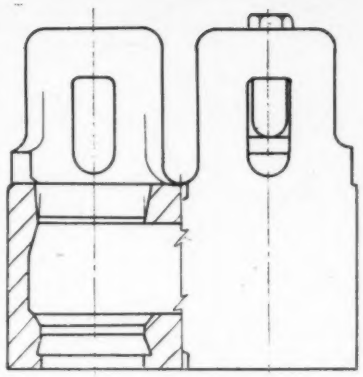


Fig. 11. A header designed to serve as a return bend.

always assuming that the feed, which might be brought in at the top of the convection bank, is not too hot. These units are often of considerable length for large duties and built with two or more stacks.

In Fig. 10 are shown the two parts of a box-type heater: a radiant section and a convection section. No attempt will be made to describe the multitude of variations of units built out of these two parts. Convection sections have been fitted on all six sides of the box, two boxes have been put together with a convection section in between, and boxes have been built which are not 'square.' In size they vary from very small to great units absorbing several hundred million B.Th.U./hr. Generally used now for larger duties, they are specially designed for the individual job and, depending on the price of fuel where they are to be used, to any desired thermal efficiency short of 100%. The general rule is to transfer the larger portion of the heat in the radiant section and remainder in the convection bank, adjusting the heat flux to suit the fluid being heated.

Controlling coke formation without headers

A short mention is now needed of a subject which has aroused strong feelings. This is the subject of headers. A header is, in this context, a device built to serve as a return bend with two plugs in four (Fig. 11), the whole normally made of cast steel.

There is a theory that all fluids coke and that the only way to get coke out is by boring out the tubes. This is not so. It is true that many fluids will coke even if the operation of the heater is good; some will coke severely. But it is also true that many fluids will not coke much unless the heater has been wrongly designed. With proper selection of radiant rates, even severe cokers can be kept quite clean. It is true that in some cases it is advisable to install headers, but it is equally true that for many duties they are only a disadvantage and a needless expense.

For example, if a unit is heating one of the heat-transfer oils, providing that it has been properly designed in keeping with the principles noted above, coke formation will be negligible. If coke does occur, it can be removed by 'burning out.' The heater is emptied of oil, a controlled quantity of steam and air blown through the tubes and heat applied outside the tube by lighting the burners. Properly done, this process can remove the heaviest coke deposit without risk and usually take only one-quarter to one-third the time taken to bore out. If the coke deposit is heavy, it will take longer than for a light deposit, but burning out is still a time saver.

The use of this technique means that continuous heat-absorbing elements can be used, the price of the unit reduced and the fear of leaks at headers eliminated.

Parallel passes

A further point, which might not occur to anyone unfamiliar with the use of direct-fired equipment for materials likely to coke, is the necessity for controlling the flows in parallel passes. To illustrate this, imagine a unit with four parallel passes fed from the same pipe and collected in one pipe. Each parallel pass is a resistance to fluid flow.

Suppose that these are properly designed and are each to carry the same amount of liquid. This they will do when clean, but, if for some reason a small obstruction occurs in No. 1 pass, say a small area of coke forms, then No. 1 will carry less oil than 2, 3 or 4, the velocity will drop, the liquid film temperature rise and coking be accelerated until No. 1 is substantially blocked. To avoid this, it is only necessary to put a valve in the inlet and a thermometer in the outlet to each pass (Fig. 12 (*b*)). By this means a simple and effective check

(*Concluded on page 68*)

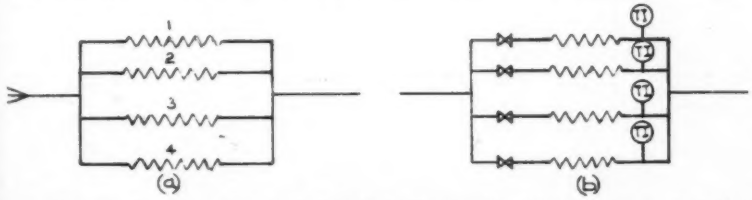


Fig. 12. (*a*) A unit with four parallel passes. (*b*) Inlet valves and outlet thermometers in position.

Wooden Vessels in the Chemical Industry

By W. T. Colyer
(Carty & Son Ltd.)

When it comes to choosing a material of construction for containers for the large-scale storage and processing of corrosive liquids, wood is often overlooked. Perhaps this is because the average chemical engineer is not so sure about the properties of wood as he is about those of the newer, more publicised, materials. In this article the author clears away some misconceptions about wood and describes its applications as a material for vat construction.

WOOD is a difficult material about which to give specific instruction because it is subject to the rather wide variations which arise from its being a natural growth. There is, too, a feeling that wood is 'old-fashioned,' and that 'progress' demands the use of the latest synthetics, linings, etc. There is occasionally also a supposition that it is not possible nowadays to obtain the high quality seasoned timber that was available before the war, and in particular that pitchpine, a favourite timber in the chemical world, is no longer obtainable.

Some who are unfamiliar with the usage of wooden vats have the impression that their contents cannot be boiled; some, associating vats with whisky and similar liquors, are even unaware that wooden vats are used in the chemical industry at all.

In Britain, where the vat trade is a small one and not able to spend large sums on publicity, there is less appreciation of the potentialities of wooden vessels than in America, where they are more wood-minded, and where in consequence the vat trade is powerful.

Properties and uses of wooden vessels

Wooden vessels are traditional but not old-fashioned. The basic characteristic which makes wood such a valuable material is its natural resistance to chemicals. It is thus in contrast to steel, which has to be expensively treated or lined before it can be used for many corrosive liquids, and even then is dependent for its life on the continuing effectiveness of such protective devices. In a sense wooden vessels can be said to thrive on chemicals, the presence of which prevents the breeding of the micro-organisms which are normally liable to attend wood sooner or later and cause it to decay. This explains the seeming anomaly that a wooden vat for a dilute chemical will usually outlast one for plain water.

Timber supply difficulties are over and nowadays a variety of high quality softwoods and hardwoods are available. In particular, pitchpine is back again in as good quality as ever it was before the war.

Wooden vats can be used not only for boiling but the majority of processes for which wooden vats are used in the chemical industry are at or near boiling temperature. One reason for this is that some alternative forms of container which are satisfactory for low temperatures will not withstand heat, whereas a wooden vat will. A typical function for which a wooden vat is normally chosen is the Twitchell or similar fat-splitting process, which involves boiling fatty acids.

Certain acids, such as nitric and hydrofluoric, are destructive to wood. So also is caustic in concentrated form, although caustic solutions may be used in wooden vats as acid neutralisers.

Apart from the above it can be said that the great majority of acids and other corrosive liquids in their dilute forms as normally used in industry can be satisfactorily contained in wooden vats. Wooden vessels are specially useful when, as so often happens, the contents involve several different kinds of destructive elements, either in succession or simultaneously. To give a simple example: rubber lining normally resists hydrochloric acid, but if oil is also present it is useless. The wooden vat takes both acid and oil in its stride.

It is for this reason that wooden vats are the ideal form of container for effluents, which are usually mixtures, and inconsistent mixtures at that, of a variety of harmful elements.

The natural resistance of wood to chemicals at any temperature up to and including boiling makes it useful in a large variety of trades and in processes carried out by makers and users of acids, alkalis, colour, dye, soap, detergents, leather, vulcanised fibre, ink, paste, gum, etc. Wooden tanks are used for water softening processes, electrolytic processes, photograph and film developing, fur and skin dressing, pickling and acid cleansing of metal parts, etc. The largest firm of radiator manufacturers in the country use unlined pitchpine tanks for their boiling hydrochloric acid pickling process, certainly not for want of testing every possible alternative. The needs of national defence call for batteries of large wooden tanks for boiling gun cotton.

Variety in construction

In addition to the basic shapes, round and rectangular wooden vessels can be made to a variety of special shapes to meet particular needs. They can be fitted with agitating gear, in which case the stirrer itself can also be in wood, so that no metal at all comes into contact with the contents. The special stresses involved by vacuum filter vats can be met quite successfully with wooden vessels.

Wood lends itself ideally to the manufacture of large revolving drums as used by tanners and others, fitted internally with baffles. Vats can be made with sloping, dished or conical bottoms. They can be fitted with partitions, and with heads or covers fixed or removable, of a type to suit the individual requirements of a particular process. Wooden outlet taps can be fitted, made of lignum vitae, but the size range of these is rather limited, as it does not exceed 1 in. diameter bore.

Potable liquors

We have so far been considering the usefulness of wooden vessels for the chemical trade generally, because it is naturally in that field that corrosive liquids are mostly handled. It is worth mentioning however that even in the realm of potable liquors similar problems arise. The malic acid of the apple, for instance, is extremely destructive to metals, and that is why cider vats are normally in oak. For the same reason vinegar calls for wooden vessels in all stages of its brewing and storage. Tartaric and citric acids are prepared in wooden vats, which are also employed for the medicinal and fruit products for which these acids are needed. The huge washbacks used by distillers for the first stage of the distilling process—several of these at a Hammersmith, London, distillery, each hold 90,000 gal.—hold a liquor containing an acid which, although only very dilute, is sufficient to attack steel. In the case of other potable liquors the use of wood avoids the objectionable interaction between container and contents which is otherwise liable to take place.

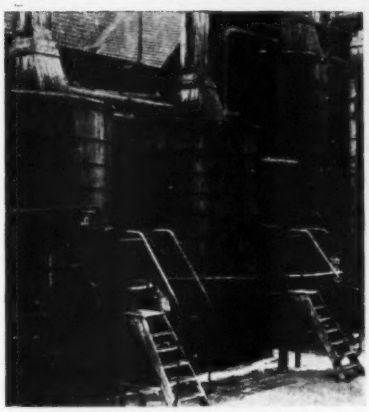
Vatmaking is a highly specialised craft. Whereas the properties of most other raw materials are consistent and recorded in textbooks available to all, timber can only be chosen, seasoned, selected, prepared and built up into lastingly effective wooden vessels by those with long experience of the trade.

Expertly made from the right timber, wooden vessels are steadily increasing the scope of their usefulness parallel with the development of industry as a whole and the chemical section in particular.

Apart from actual liquids, wood is useful in dealing with corrosive fumes. Gas scrubbing towers, having the function of both removing noxious chemicals from fumes which would otherwise pollute the air, and of recovering these valuable chemicals for further service, are made in wood, together with most of their internal fittings. Alternatively, where the question of cleansing or recovery does not arise wood is the ideal material for ducting chemical fumes away from the processing room.

Wood is used for the plates and frames of filter presses and for numerous other items of plant in chemical factories where most metals would be vulnerable to the corrosive atmosphere.

One particularly useful feature of wooden vessels is their easy assembly on the site to which they have been sent in fully prepared pieces. Moreover if, as often happens, the development of the process or other circumstances necessitate alterations in the layout of the plant, wooden vats can be easily dismantled and re-erected in another position.



Fat-splitting vats at the Purfleet, Essex, works of Van den Berghs & Jurgens Ltd., the 'Stork' margarine manufacturers.

Costs

The range of capacities of wooden vats extends from about 20 to 100,000 gal. In general, the cost per gallon decreases as the capacity increases until about 20,000 gal., after which it tends to stiffen again. Other things being equal the circular shape is preferable constructionally and somewhat cheaper, but available space and other considerations often necessitate the rectangular shape.

Wooden vessels are very moderate in price compared with other forms of container having similar acid-resisting qualities. They are, for instance, about half the price of stainless steel and upkeep costs are low. Frequent repainting or other treatment necessary for steel exposed to corrosive elements is unnecessary with wood. Wooden vats should not be painted or covered with any airtight skin; to do so shortens instead of lengthens their life. The hoops round circular vats, being of steel, should be well painted, but this is a relatively small item. Incidentally the traditional flat driven hoop is now practically obsolete. Modern vats are cylindrical in shape without taper, bound with round section steel hoops fitted with tightening blocks. These are much easier to make and keep tight, and last much longer than the flat type, weight for weight, because a much smaller surface becomes vulnerable to corrosion.

The effectiveness of wooden vessels for corrosive liquids, or indeed for any liquid, is subject to certain important provisos. The timber must be of the type most suitable for the job. Pitch-pine has already been mentioned; available also nowadays are first class genuine Burma teak, peroba de campos (a tough Brazilian hardwood), Siberian larch and redwood, English oak, Douglas fir, etc. No matter which timber is used, it must be of the highest grade obtainable and even then it will be necessary to eliminate such natural defects as sapwood, centres and shakes; also knots to the extent that they may be harmful. Unfortunately a good deal of elasticity is possible in the degree to which such defects can be cut out. Different makers vary in this. That being so, a plant buyer may reasonably ask how he is to choose between one offer and another when the specifications of both look the same on paper. The answer is that he must be guided by what is known of the reputation of the supplying firms.

Finally there is the question of seasoning. The thickness of timbers used for vats ranges from about 2 in. to 4 in. These thicknesses do not lend themselves to kiln drying, which in any case is unsatisfactory for other reasons. This involves the much longer but sounder and surer method of air seasoning, for which purpose the sawn planks are piled with sticks between each layer to give free air passage for two to three or more years according to thickness and kind of timber.

Can a wooden vat be left out of use? The popular supposition that a vat must be perpetually filled to retain its effectiveness is not wholly true. It depends on the length of time it is expected to be out of use, and on other circumstances. The suppliers will be able to advise.

Lining wooden vessels

The foregoing observations on wooden vats all apply to vessels for use without lining. Wooden vessels can however be satisfactorily lined with lead, rubber, copper, etc., where the particular character of the contents calls for any such linings. It is worth noting in passing that the functions for which wooden vessels will not be adequate unless lined are not as numerous as is sometimes supposed. Granted the necessity for a lined vessel in any given instance, wood is usually the best material for the constructional shell, because it is less vulnerable than steel to the corrosive effects of overflows, splashes and the general presence of fumes.

Chemical Industry in Europe

AN UP-TO-DATE SURVEY

The general picture

PRODUCTION in the European chemical industry has increased during the three years 1951-53 at a rate substantially higher than the average for European industry as a whole. Increased production since 1950 has been particularly impressive in Italy (57%), Germany (43%), Belgium (22%) and the United Kingdom (20%). The O.E.E.C. Chemical Products Committee points out, however, that this trend, though satisfactory in itself, must be viewed in the light of the world situation, which has greatly changed since before the war. At that time, production in the O.E.E.C. countries represented about 50% of world production; in 1951 it fell to about 25%, while United States' production, which before the war amounted to 30% of world production, rose to over 40% in 1951.

Again, the picture is not equally favourable in all sectors of the chemical industry. Thus the output of basic and intermediate products and of certain end-products such as plastics and synthetic detergents expanded considerably, whereas for other products it remained stationary or even declined, *e.g.* in the soap industry.

The chemical industry, which is normally a large-scale producer, necessarily requires a wide market. The European industry has to face increasing competition both at home and abroad from the American industry which has the advantage of a big domestic market. This, the report states, is sufficient indication of the need for a free flow of trade among O.E.E.C. countries.

Trade between those countries could doubtless be expanded if the existing obstacles—quantitative import restrictions and customs duties—could be relaxed. The trade in chemical products at present subject to restrictions may be estimated at 20% of the total trade in 1952.

It is considered that, in general, prospects in most sectors of the chemical industry justify a certain degree of optimism for the near future.

Supplies of raw materials, previously often difficult and in short supply, became more regular in 1953. Fats and native sulphur are once more available in adequate quantities, as are certain intermediate products, *e.g.* phthalic anhydride, cresylic products, titanium dioxide, etc.

A problem arises for Italian sulphur, production of which has increased as a result of the shortage of American sulphur and which has difficulty in competing with the latter owing to high production costs.

Inorganic chemicals

Production of caustic soda, chlorine, sulphuric acid and primary ammonia has risen by 20% or more since 1950. while the increase in production of calcium carbide was slower (13%). Output of soda ash in 1953 was only 5% greater than in 1950.

Soda ash. The most important uses of soda ash are in the production of glass and washing products and in the steel industry. Activity in the first two industries has been below normal for some time, owing, in the case of washing products, to the fierce competition of synthetic detergents. The rise in production of soda ash has, therefore, been slow, but figures for the first months of 1954 show a tendency for the production of this chemical to rise rather more quickly.

Caustic soda. The rise in the production of caustic soda reflects the recovery in the artificial fibre industry, to which a large part of the production goes. The activity of the soap industry, the other main consumer, is affected by competition from synthetic detergents. This did not, however, offset the rise in consumption of caustic soda in other sections.

Belgium reports that output in that country is still not sufficient to cover home requirements and that some caustic soda must be imported. The same applies to Denmark.

In the other countries, except, for the time being, Italy and Portugal, the output of caustic soda exceeds the 1951 level—sometimes to a considerable extent. This advance is due, among other things, to a definite revival of artificial textile production and increased exports. The figure for the first few months of 1954 confirm this trend.

Chlorine. Production of chlorine has increased as a result of a stronger demand for the manufacture of plastics (polyvinyl chloride) and solvents.

There has been a large increase in Danish output in the last three years and this now covers the best part of local requirements for the production of bleaching powder, insecticides, fungicides and herbicides. It was to be noted that, except in the case of Belgium, production in 1953 was well above the level for 1951.

United Kingdom production indices for soda ash, caustic soda and chlorine combined (1950 = 100) are: 111.5 in 1951, 93.5 in 1952, 100.5 in 1953 and 110.6 for the first three months of 1954.

For the other O.E.E.C. producing countries, total indices similarly calculated for the three products combined are: 122 in 1951, 99 in 1952 and 116 in 1953.

Sulphuric acid. Production of sulphuric acid, which is one of the most important basic products of the chemical industry, can be taken as an indication of the level of production in various sectors of that industry, particularly the production of nitrogenous and phosphate fertilisers.

The output of sulphuric acid has risen steadily from year to year, except in 1952, when the index of production reflected the slackening of activity in most sectors of the chemical industry. This trend was common to practically all the O.E.E.C. countries, except the Belgo-Luxembourg Union and Switzerland, where production was lower in 1953 than in 1950, and France, where production has remained relatively stable for the last three years.

An interesting point is the increased use, in the manufacture of sulphuric acid, of pyrites and anhydrite as a substitute for natural sulphur, most of which has to be imported.

Calcium carbide. On the whole, calcium carbide production seems to be marking time and in many countries it is even declining. One of the reasons is probably that calcium carbide, which used to be an important basic material for organic chemicals, is now being increasingly replaced by other raw materials, especially oil and natural gas. However, the report shows that its use in other fields, *e.g.* welding, seems to have increased.

Primary ammonia. The rise in production of primary ammonia reflects in the main the increased demand for nitrogenous fertilisers. Nitrogen is produced synthetically in 12 O.E.E.C. countries: Austria, Belgium, France,

The chemical industry is not a single industry but a complex of industries whose products can be listed under nearly 10,000 different headings and are supplied to a wide variety of industries as well as to the direct consumer. Statistics on production of chemicals are often not published for a variety of reasons, one being that, where there are only a few producers, publication is regarded as contrary to commercial interests. Add to this the fact that there is no general agreement between different authorities and different countries as to what exactly is meant by 'chemical industry,' and it will be seen that the O.E.E.C. Chemical Products Committee was quite courageous to take on the job of compiling a report on the situation in the European chemical industry today. The report they have produced does them credit, for out of the welter of statistics has come a clear guide to the way Europe's chemical industry is going. First they survey the situation in the chemical industry of O.E.E.C. countries as a whole, setting out the main economic aspects. Then they show the situation of the chemical industry in each of the individual countries. Finally they describe in greater detail the development of production and trade in different sectors of the industry. This article, which includes extracts from the report, concentrates mainly on heavy chemicals.*

Germany, Iceland (since 1953), Italy, the Netherlands, Norway, Portugal (since 1952), Sweden, Switzerland and the United Kingdom.

The fertiliser industry is by far the largest consumer of primary ammonia; then come explosives (nitro-cellulose, nitro-glycerine and other organic nitrates) for both military and civilian purposes, followed by numerous other industries, *e.g.* refrigeration.

In Italy, the synthetic nitrogen industry has been extensively developed since the war. Of all the member countries of O.E.E.C., Italy shows the largest increase (74%) in output of primary ammonia since 1950.

In the United Kingdom, increased plant capacity combined with easier coal supplies have contributed to a steady increase in ammonia output during the last few years. The demand for fertilisers and for industrial products has reached new record levels.

Organic chemicals. Production of methanol, acetic acid and acetone increased from 1950 to 1953 by between 20 and 30% in the countries for which information is available. For the area as a whole, the rate of increase may, however, be even higher, particularly as regards acetone.

The production of phenol, which is obtained either as a by-product or by synthesis, has increased even more—at least, in the six countries for which information is available. Production in 1953 was probably nearly 40% above the 1950 level. The synthetic product accounts for by far the greater proportion of this rise. Phenol is used mainly in the manufacture of plastics materials, and also as a raw material in the pharmaceutical, tanning and other industries.

The production of naphthalene shows a weaker tendency owing to lack of demand in some countries, particularly the United Kingdom and Italy.

Benzole is, in O.E.E.C. countries, derived mainly from the coke oven process and the carbonisation of coal. Its production is closely connected with the production of coke. Production of benzole has been rising ever since 1950 and, in 1953, was 25% above the 1950 level.

Miscellaneous sectors

Explosives. Production of explosives in the countries for which information is available has risen markedly. As only explosives made for civilian use were under consideration, the increase in production must mainly be attributed to their increased use in mining.

Plastics materials. Figures available show that production is rising rapidly. This sector has probably developed more during recent years than any other sector of the chemical industry, and its rate of expansion is mainly limited by the economic supplies of basic materials, particularly from the petroleum chemicals industry.

Synthetic rubber. It is interesting to note that one major feature of the petroleum chemical activity in the U.S., the production of GR-S and butyl rubber from petroleum-based materials, has never been duplicated in Europe. Plans are now in hand, however, in France and Italy for the manufacture of these two types (butyl in France and GR-S in Italy, where an annual capacity of 30,000 tons is planned). The possibility of manufacturing GR-S and butyl rubber is being examined in other countries. In addition, plans are well advanced in the United Kingdom for the manufacture of specialised types of synthetic rubber outside the GR-S/butyl range, and similar plastics materials.

Sulphurous materials

In 1953, total consumption of sulphur in all its forms amounted to 4,165,400 tons and exports to non-member countries to 108,600 tons. Total production was 2,867,100 tons and thus the net deficit of sulphurous raw materials in O.E.E.C. countries works out at 1,406,900 tons. Imports from non-member countries amounted to 1,024,400 tons and, if imports of pyrites and zinc blende from overseas territories and from British Dominions are estimated at 250,000 tons, the total amount taken from stock was probably about 150,000 tons.

The production of sulphurous materials as a whole has increased continually throughout the period under review and is now more than 20% greater than in 1949-50. Consumption has increased compared with 1952, but is still below the level of the peak year 1951. Imports which rose constantly from 1949-50 to 1952 fell off in 1953, probably owing to the considerable stocks held by member countries at the beginning of the year. Exports are declining. In 1952 they were 12% lower than in 1951 and, in 1953, 25% lower.

The decline in exports is being felt by most of the large exporters of sulphurous materials. Shipments from Italy, Norway and Portugal, which together accounted for 90% of total exports in 1949-50, fell from 675,000 tons in that year to less than 400,000 tons in 1953. The decline in Italian sulphur exports which were only 6% of the 1949-50 tonnage in 1953 is particularly serious, and it is to be hoped that ways and means will be found whereby the future level of production is not compromised by the increase in stocks.

Developments in miscellaneous European countries

In Austria, the recent improvement in production was particularly felt in the caustic soda and nitrogenous fertiliser fields, and likewise soaps and detergents. The increasing importance of organic chemicals from oil and natural gas has led to the construction

* 'The Chemical Industry in Europe,' Organisation for European Economic Co-operation, Paris, 1954. Pp. 154, 9s.

of a natural-gas-cracking plant by the Municipal Gas Works in Vienna. Another plant has been built to produce polyvinyl chloride.

Belgium is planning to set up a petroleum chemicals industry.

Of Denmark's total production of chemicals (which in 1952 amounted to little more than about $87 million), only 10% represented basic items such as chlorine, sulphuric acid, glycerin and alcohol. From 20 to 25% of total production is exported.

In the French inorganic chemical industry there has been continuous development in the production of chlorine and chlorine derivatives, particularly solvents, due to considerable modernisation in this industry. Developments in petrochemicals and plastics are also noted, while the dyestuffs industry is carrying out a large-scale programme of modernisation. Production of detergents has been trebled during the past three years.

As previously shown, the greatest progress in chemical production seems to have taken place in Italy, where the present level is well over 100% above the 1938 level. The increased importance of the chemical industry to the Italian economy has been due in particular to development in plastics, detergents and nitrogenous fertilisers.

East Germany's Chemical Industry

INCREASING USE OF INDIGENOUS RAW MATERIALS

THE East German chemical industry is working to full capacity and employs 250,000 workers in day and night shifts. It has expanded considerably since the end of the war, when the industry faced two enormous difficulties—the damage that had been done to plants by bombing and the separation of the industry from the West German producers of steel, chemical apparatus and many basic chemicals, such as sulphuric acid, which the East German works used to get from the West.

How these difficulties were overcome and in which directions the industry is likely to develop has been described in the East German journal *Chemische Technik*, of October, 1954.

The chemical industry of East Germany is based on the brown coal deposits north and south of Leipzig and the salt mines between Halle and the Harz mountains. Other important raw materials are anhydrite, limestone, kaolin and the waste products of forestry and agriculture, especially wood, straw and molasses.

Sulphuric acid and caustic soda

But no chemical industry can exist without a sufficient supply of sulphuric acid, and East Germany requires this acid particularly for the manufacture of superphosphate and rayon. Plants were therefore erected to make sulphuric acid in the usual way from pyrites. There is, however, only one very small deposit of pyrites in the Harz mountains, and most of the mineral had to be imported. To make the industry independent of imports, it is intended to make sulphuric acid in future from indigenous raw materials such as anhydrite and magnesium sulphate. The Wolfen Chemical Works have already started to manufacture sulphuric acid from anhydrite and produce an excellent cement as a valuable by-product.

A heavy chemical which the East German industry requires particularly for making detergents and artificial fibres is caustic soda. Both the usual methods, the electrolysis of sodium chloride and the caustification of sodium carbonate, are based on minerals which are found in the country: salt and limestone. But electricity is expensive, as it must be generated from brown coal. The electrolytic method has, on the other hand, the advantage of yielding chlorine as a by-product. Demand for this, particularly for the manufacture of vinyl chloride plastics, is increasing.

Fertilisers

Before the war, Germany was responsible for nearly 70% of the world output of potassium compounds and, when Germany was divided, 60% of this production happened to be in Eastern Germany. Much of this is available for export.

Production of phosphatic fertilisers is more difficult, because all phosphates must be imported, and most of them come from Russia in the form of apatite. Here, once again, sulphuric acid is needed in the conversion of this raw material to superphosphate. Attempts have been made to replace the sulphuric acid treatment by other methods, and some success has been achieved recently by fusion with magnesium compounds or with caustic soda.

The inorganic residues of the fermentation of molasses are also used now to make fertilisers, which have the advantage of containing phosphorus as well as potassium. The plants for making ammonia by the Haber process are going to be enlarged to increase the production of nitrogenous fertilisers and of nitric acid, some of which will be used for the treatment of apatite and to produce a fertiliser containing both phosphorus and nitrogen.

Another obligation of the chemical industry towards agriculture is the manufacture of fungicides and insecticides. Most of the chemicals used for this purpose contain copper or mercury and, as these metals are in short supply, research work is in progress on finding substitutes which do not contain metals. Chlorinated nitrosalicylic acid has proved to be useful for some purposes.

Calcium carbide and metals

Limestone and coal are the raw materials of another branch of the chemical industry. These two minerals are converted in electric furnaces to calcium carbide, and this is used to make acetylene, which is the starting point for the manufacture of many important organic substances. The production of such well-known works as the Buna works at Schkopau is almost completely based on acetylene. Certain limits are, however, imposed on the development of this branch of the industry because of the enormous consumption of electrical energy for the manufacture of carbide. Much research is therefore going on to replace carbide by other materials, *e.g.* the hydrogenation products of brown coal tar.

The metallurgical chemists, too, are directing their research increasingly to the replacement of imported ores by raw materials available in the country. Aluminium is at present made from imported bauxite. Attempts have been made for years to find a suitable method of extracting aluminium from clay, and it is expected that these experiments will soon reach a stage where manufacture on a large scale can be started. As regards magnesium, the raw material position is favourable, and the country should soon be able to export considerable quantities of this metal.

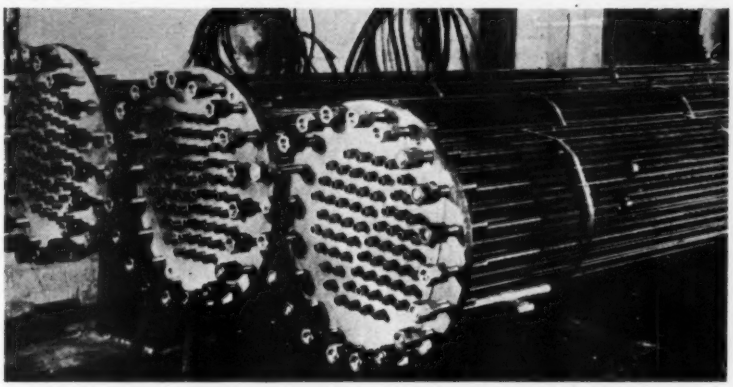
The manufacture of artificial fibres is already important and will be considerably increased in the near future. *Perlon* fibres are made from lactam, which is obtained from phenol, a product of the destructive distillation of brown coal.

E.R.

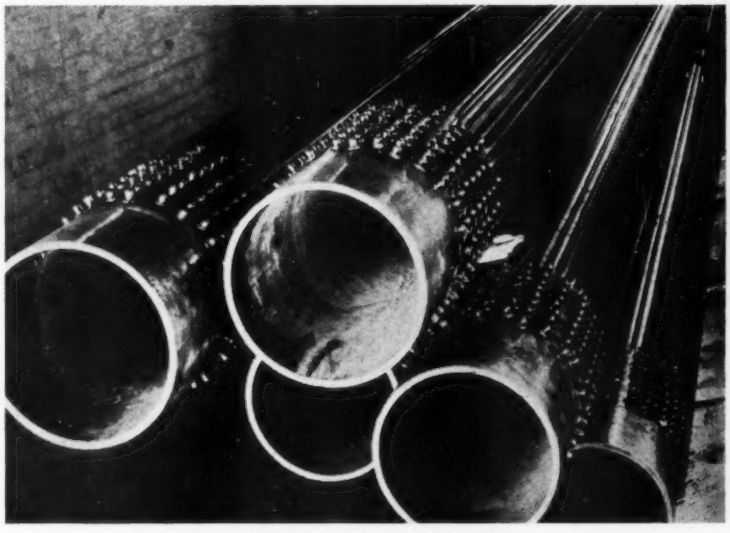
Heat Exchangers with Finned Tubes

HEAT exchangers incorporating tubes with longitudinal fins have been in use in the petroleum, chemical and allied industries in America for many years, and some few examples have been imported into the United Kingdom. But recently, manufacture of this type of heat exchanger has been started in the U.K., under American patents. Birwelco Ltd. (formerly the Birmingham Welding Co. Ltd.) have formed a subsidiary company, Brown Fintube (Great Britain) Ltd., for this purpose.

Until recent years little has been known about the factors affecting heat transfer using extended surface in this form. Much research, both theoretical and practical, has been accomplished during the past two decades, with the result that the design of this type of equipment can now be evaluated with complete certainty.



Tank suction heater bundles ready for inserting in their shells.



Finned tubes of 9 in. diameter.

Design features

The whole purpose of fin surfaces is to cut down the amount of tube which must be used in a given heat exchanger. Certain fluids pick up heat less readily than others and it is therefore sometimes of advantage to arrange that one fluid in the heat exchanger has a bigger surface area to pick up or give up heat than the other fluid.

The construction of a finned tube involves the satisfaction of two requirements: the fins must be perfectly bonded to the tube, and the tube wall must not be weakened in any way. This rules out any mere mechanical bond, and the method of construction used solves these problems in a very neat manner. The fins are formed in pairs from flat strip by rolling the latter into a truncated 'V' which is then welded or brazed to the outer surface of the tube. The resulting finned tube is thus of completely integral construction and detachment of the fins is impossible without actually destroying the fins.

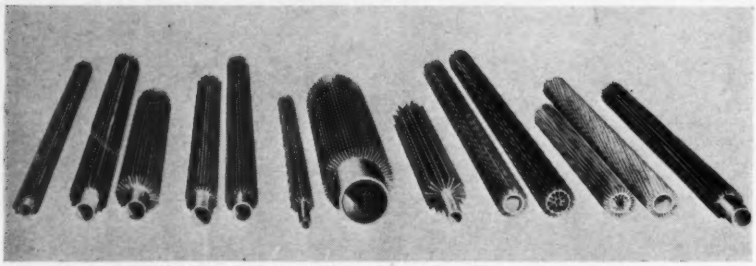
The ratio of outside surface to inside surface can be extremely high: ratios of 8: 1 or over are frequently used. The actual ratio depends entirely upon the required duty of the exchanger and the fluids involved.

Allied to the advantage intrinsic in the finned tubing itself, is an even more important factor: with so much surface available with relatively short lengths of tube of small diameter, it becomes practicable to design heat exchangers of useful size incorporating only two tubes, whereas, when using plain tubes, perhaps 15 or 25 tubes would be necessary. Thus these two tubes can each be shrouded in a closely fitting outer tube, providing a passage between the inner and outer tubes through the fins for one liquid, and through the centre of the inner tube for the second fluid. The result is a heat exchanger of small size and light weight with its obvious advantage where handling and dismantling or re-assembly is concerned. Cleaning and repairing are also facilitated, since there is no necessity for heavy lifting tackle and special handling arrangements as would be the case with an equivalent bare tube exchanger.

On a double-pipe, finned-tube exchanger, the seal between the inner and outer tubes can be very easily accomplished by the use of a simple metallic ring joint. Heat exchangers of this type can be connected together should the duty requirement be larger than can be accommodated in one double-pipe exchanger alone.

Standard units

The greatest field of usefulness for extended (unequal) surface equipment is transfer of heat from a fluid of low viscosity from or to a relatively viscous fluid. However, longitudinally finned, double-pipe 'hairpin' exchangers have also been used extensively in transferring heat between two fluids having similar heat-transfer characteristics. In these cases, the tubeside fluid generally flows at high velocity, utilising the maximum allowable pressure drop in order to obtain the best heat-transfer coefficient possible, whilst the



An assortment of finned tubes giving some idea of the range of sizes and types that are made.

finside fluid may flow at moderate velocities.

The 'hairpin'-type sectional exchanger is available in a variety of sizes and materials. These units are extremely flexible and can be manifolded into any required arrangement of series and parallel flows to perform any given duty; thus variations in duty requirements can be catered for by cutting sections in or out of stream. A whole plant can be equipped involving heat exchangers of one or two standard sizes only, the sole difference between the various exchangers being the number of sections and the banking arrangements.

The general construction is simple, consisting of a U-tube shell with a U-tube inner element, finned or plain as dictated by service requirements. At the return bend end, the cover plate can be provided with a tongued and grooved joint for high-pressure services. The shell/tube seal is particularly suited for hazardous fluid services, there being no possibility of leakage of either fluid. Taper surface joints, which might become damaged during maintenance, are avoided.

The standard range of sections gives surface areas ranging from 3 sq. ft. up to over 250 sq. ft. per single 'hairpin' section: pressure ratings are standardised for 600, 1,200 and 1,800 p.s.i. on the shell side; much higher pressures can also be accommodated inside the tube, some having been designed for 10,000 p.s.i. for synthesis gas services.

These exchangers are made in a variety of materials including carbon steel, chrome molybdenum steel, stainless steel, admiralty brass, cupronickel, aluminium brass, *Monel*, *Inconel* and aluminium.

Bundle exchangers of the U type can be used as steam/oil heaters when dealing with large flows, such as for tanks suction heating or as line heaters. They may also be used as vapour condensers or coolers with large water flows. The construction of the units resembles that of the conventional plain U-tube and shell exchangers, except that finned tubes are used with a corresponding increase in available surface area for a given size of shell. An interesting design point is that the head may be removed without disturbing the tubesheet; this is a great advantage in tank suction heaters, for it is thus unnecessary to empty the tank when removing the head assembly.

The Leonard Hill Technical Group—February

Articles appearing in some of our associate journals this month include:

Food Manufacture—Annual Reviews on Milling and Confectionery; Pea Soup; Chocolate Manufacture in Switzerland; The Transport Position; Manufacture of Vanilla Extract.

Manufacturing Chemist—Terpeneless Oils; Technology in the Fine Chemicals Industry, 6; Aureomycin Manufacture; Manufacture of Perfumery Chemicals, 1; Disinfectant Testing: Developments in U.S.; Progress Reports on Pest Control Chemicals and Chemotherapy.

Paint Manufacture—Styrenated Drying Oils and Resins; Thixotropy and Paints, 2; Economics of the Paint Industry, 2; Increased Research and Expanding Production; Misting Problems in Printing.

Petroleum—Instrumentation and Automatic Control in Oil Refineries, 2; Azeotropic and Extractive Distillation, 3; Oil Refineries and Corrosion by Water; The T.C.C. Unit at Coryton.

Fibres—Recent Developments in Copolymers, 2; Fibrous Minerals, 2; Transforming Cotton into new Textile Products; The Effect of High-Temperature Treatments on the Moisture Absorption of Viscose Rayon; Fibre Data Sheet.

Atomics—Some Aspects of Radiography in the Shipyard; Potato Storage and Gamma-Radiation; Cosmic Radiation, 1.

Corrosion Technology—Corrosion of Ships; The Corrosion of Tinplate by Foods Packed in Cans; Localised Corrosion of Steam Boilers; Corrosion-Resisting High-Silicon Iron Alloys; Corrosion Research Laboratories.

Determining Solubilities of Long-Chain Organic Compounds

SCIENTISTS of the U.S. Department of Agriculture have reported an equation for relating solubities of homologous long-chain organic compounds to the number of carbon atoms in the molecule, which should be of practical importance to industrial processors of vegetable fats and oils, as well as to researchers investigating these commodities.

This relation provides a method for determining solubilities not available in the literature for long-chain organic compounds, simply from a graphical correlation of the published solubility data for homologous members of the same chemical series.

Its use eliminates the necessity of synthesising and purifying the missing members for making the tedious solubility measurements. It is convenient also for smoothing out experimental solubility data, and for locating discrepancies caused by experimental error, or by an impurity in one sample in a series.

When the molar solubilities of homologous compounds are plotted on a logarithmic scale against the number of carbon atoms, solubilities of the missing members can be predicted by interpolation or extrapolation, since the solubilities of the complete series fall on a smooth curve.

This method of plotting has been applied to the published solubility data for 138 systems involving 11 homologous series of long-chain organic compounds and 17 different solvents, over a wide range of temperatures.

The charts show at a glance the agreement between the available solubility data for the members of each homologous series in each solvent. They cover the solubility data for homologous fatty acids, their methyl esters, primary amines, symmetrical secondary amines, primary alcohols, symmetrical ketones, nitriles, amides, anilides, N, N-diphenylamides, and esters of stearic acid, in such solvents as benzene, cyclohexane, carbon tetrachloride, chloroform, ethyl ether, glacial acetic acid, ethyl acetate, butyl acetate, acetone, butanone, methanol, 95% ethanol, isopropanol, *n*-butanol, nitroethane, acetonitrile and water.

The method is reported in an article by E. L. Skau and R. E. Boucher (*Journal of Physical Chemistry*, 1954, **58**, 460). The charts are contained in an illustrated publication issued by the Agricultural Research Service, ARS-72-1.

Research and Industrial Productivity

POINTS FROM THE D.S.I.R. WORKING CONFERENCE

Re-equipment and sulphuric acid manufacture

THE most efficient and cheapest way of producing sulphuric acid is to start from elemental sulphur and to proceed *via* the contact process, but there are still many chamber plants using a variety of raw materials—sulphur, spent oxide and pyrites. The sulphuric acid industry is an old-established and stable industry and all the processes are well known, so that an accurate estimate can be given of how much it would cost to install a sulphur-burning contact acid plant instead of a chamber plant, and to calculate the saving in operating costs. It would therefore appear to be a simple matter to decide whether to scrap the old plant and to install a new one.

There are, however, the following points to be considered. First, should the new plant be of the same capacity as the old plant, or should it be larger? On the whole, chamber plants are small, whereas very large contact acid plants can be built, and a considerable reduction in costs can be achieved by increasing the scale of operations. But if a much larger plant is installed, will it be possible to sell the output over the whole life of the plant, which will be of the order of 30 years? If there is insufficient market for the whole of the output, the estimated improvement in costs will not be realised.

Secondly, a long-term view must be taken of the raw material supply position. Sulphur was in short supply a year or so ago, and may be so again. If, therefore, elemental sulphur were to become no longer available in the future or were to increase very much in price, it would be necessary to let the plants stand idle or to modify them to use other sulphur-bearing materials.

Now the cost of converting a chamber plant to burn, say, pyrites, is not large, whereas to convert a contact plant to use pyrites would entail a capital expenditure at least double that of the original plant. It is therefore obvious that, even in this case where all the technical data are completely known, the over-riding long-term considerations are the supply of the raw materials and the probability of selling the output.

The foregoing points were made by **Mr. A. H. Wilson,** F.R.S., director of research and development of Courtaulds Ltd., in a paper presented at the recent D.S.I.R. Working Conference on Research and Industrial Productivity. Mr. Wilson chose the example of sulphuric acid manufacture to illustrate that there are always a number of possible alternatives when considering re-equipment and even in apparently simple cases a number of matters of broad commercial policy must be decided before going into technical and economic details.

Towards the automatic factory

The conference was organised by the Department of Scientific and Industrial Research in association with the British Productivity Council and the British Institute of Management, and its object was to discuss how research is helping to increase industrial productivity and what more can be done.

In his opening talk, **Sir Ben Lockspeiser,** secretary of the D.S.I.R., said the fully automatic factory was on its way. The oil, chemical and food processing industries have been steadily moving away from batch processing to continuous operation embodying a measure of automatic control, and the metal-using industries in their engineering shops are moving in much the same direction, the logical end of which lies in the fully automatic plant or factory. The fully automatic electronic digital computer is emerging from the research laboratory as a master mechanism to integrate and control automatically the discrete steps hitherto involved in the process industries and in the manufacture of engineering products.

He said we were not likely to get much, or perhaps any, advantage from this revolution in technology without a new synthesis within the living body of industry. Technology today is calling an expensive tune and it will not benefit anybody, either in private industry or in any form of state industry, to invest the large capital required for the new developments that are already upon us if the plant cannot be operated fully and economically.

On the question of making materials go further, Sir Ben said that we can, no doubt, with the aid of modern chemical technology and metallurgical processes, exploit ores of very low concentration hitherto considered of little value, as has been done in the case of uranium. Nevertheless, he pointed out, there is a time lag in all such developments, even if they come about, and now more than ever we have to learn how to make what we have go further and use what we have to a better purpose.

Selenium is a typical example of a material of which supplies are very limited and for which there are several industrial uses. It is of particular value to the electrical industry for the manufacture and export of rectifiers, and it is used also by the glass industry for decolorising glass containers, particularly milk bottles.

If the export of rectifiers is in conflict with the attractive appearance of bottled milk, we may be paying too high a price for keeping up appearances.

Chemistry and food production

Another speaker was **Prof. S. Zuckerman,** C.B., F.R.S., deputy chairman of the Advisory Council on Scientific Policy. His subject was 'Renewable Resources of Raw Materials.' Dealing with wood pulp as a raw material for synthetic fibres, he said the facts suggest that where cotton is not specifically necessary, it is hardly likely to compete economically with synthetic fibres made from this form of cellulose.

Phosphoric fertilisers do not come under the category of creatable or renewable resources, he pointed out, nor do salts of potassium. Nitrogenous fertiliser does, and in most countries the returns expected from its application are much greater than those from phosphorus or potassium (an average estimate is that nitrogen would give three times the yield of an equal quantity of phosphorus or potash fertiliser). It has even been estimated that 1 ton of fixed nitrogen will produce enough extra food to feed about 40 people a year. It therefore seems reasonable to increase the efficiency of photosynthesis by removing the limiting factor in the supply of nitrogen, rather than to use our supplies of fixed nitrogen to try to synthesise proteins by chemical processes which are dependent on our reserves of fuel.

Our reserves of fertiliser nitrogen are limited by the supply of energy needed to convert atmospheric nitrogen into a form available to the plant.

Where the energy for synthesis is derived from fossil fuels, the balance of the carbon cycle depends on our agricultural efficiency. Thus approximately 5 tons of coal are needed to produce 1 ton of fertiliser nitrogen. This in turn produces about 10 tons of starch equivalent, so that the net gain in carbon fixed over that present in the coal is not large (coal 80% C, starch 44% C). Nevertheless, it is food we want, and for years we shall have to depend on our supplies of power, including coal, in order to increase agricultural output.

Considerable capital is also needed to produce fertiliser nitrogen—as much as £200 per ton/year of nitrogen. Furthermore, the running costs per unit of nitrogen tend to be inversely proportional to the volume of output, so that the process favours large-scale manufacture. For that reason, interest has recently been shown in a new development for fixing atmospheric nitrogen in smaller plants. This process is based on the thermal conversion of the N_2 and O_2 of the air into nitric oxide, from which nitric acid is obtained on solution in water.

Until the mechanism of photosynthesis is not only fully understood, but also reproduced in the workshop, we cannot look to the chemical industry for any significant addition to our supplies of food. Even if we could, we also need to note that the starting material for synthetic food production would have to contain carbon, and that consequently our supplies of coal and petroleum oil would not only have to provide the raw material, but also the energy to effect the transformation into foodstuffs.

Even if we could synthesise food in bulk from coal or petroleum products we would, therefore, be doing so from a wasting asset. If we wish to increase productivity in the field of our supplies of food, our efforts in synthetic chemistry should be focussed on the manufacture of vital products which are obtained at a small cost of energy and materials.

British Patent Claims

Stabilising calcium cyanamide

Calcium cyanamide granules are stabilised by treatment with nitric acid. The granules should be kept in rapid motion in a rotary drum or mixer and are sprayed with 10 to 15% of 40 to 50% nitric acid while the temperature is kept below 100°C. Continued rotation of the drum causes polishing and simultaneous partial drying of the granules, which are then stored in a closed container and subsequently dried with hot air.—678,194, *Sud-deutsche Kalkstickstoffwerke Akt.-Ges.*

Separating gaseous mixtures

A process is described for separating adsorbable constituents from gas mixtures by means of two adsorbers which are alternately charged and partially regenerated by washing gas free from adsorbate. The adsorbent is charged to below 50% of its equilibrium charge and below 90% of its break-through charge, and the time of charging and regenerating is substantially 5 to 30 minutes.

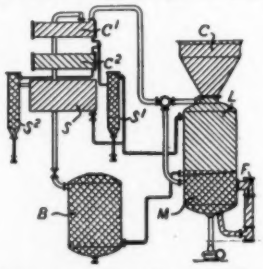
Washing gas may pass through the adsorbers in the opposite direction to the gas treated; 3 to 4 volumes of washing gas per volume of feed gas may be used. Preferably the adsorbent is of 1 to 2 mm. grain size and is arranged so as to have a cross-sectional area of 0.5 to 1 sq.m./1,000 cu.m. of gas treated and a layer length of at least 1.5 m.

The whole process may be carried out at or below room temperature, or the temperature of the washing gas may be increased by at least 3°C. for each halving of the ratio of the volumes of washing gas and feed gas. The adsorbers may be built one inside the other to facilitate heat exchange, and the change-over may be effected automatically when the adsorbent reaches a predetermined temperature.

In an example 99.5% of the carbon dioxide present in air is removed using activated charcoal as the adsorbent, and nitrogen free from carbon dioxide as the washing gas. Specification 633,137 is referred to.—677,150, *Ges. für Linde's Eismaschinen Akt.-Ges.*

Extracting sugar-cane wax

Hard wax and fatty by-products are separately recovered from the filter cake or residues of cane-sugar manufacture by extracting the material with a selective organic solvent. This at ordinary temperatures dissolves the fatty matter and not the wax, and at



a higher temperature dissolves the wax. The solution of the fatty substances is separated at a temperature below 25°C., and then the wax is dissolved at a higher temperature in the same solvent. The solutions of fatty substances and wax are collected in separate receptacles and the solvent is distilled off from each.

The solvents specified comprise paraffin hydrocarbons singly or in admixture, containing at most 10 carbon atoms in the molecule, such as hexane, and a petroleum spirit of B.P. 90 to 105°C.; and halogenated hydrocarbons such as trichlorethylene. The higher temperature of the solvent for the wax extraction is specified as at or near the boiling point of the solvent used.

In a suitable plant for effecting the extractions, an extractor *L* is provided above a separate chamber *M*. The latter chamber is connected with a calandria heater *F*, and a hopper *C* is arranged on the extractor *L*. The extractor is connected by piping to a still *B* which is in circuit with a condenser *C1*, cooler *C2*, solvent tank *S* and automatic water decanters *S2*, *S1*.

In operation the filter residue is charged into the extractor *L* together with solvent from the tank *S* at a temperature below 20°C. After stirring, the solution of fatty matter flows through a filter bottom to the still *B*. The vapours from the latter pass to the condenser *C1* and, after condensing, the liquid flows through the cooler *C2* and the water decanter *S2* to the solvent tank *S*, and is again fed to the extractor *L*. This continues until the fatty matter has been extracted. The still *B* is then isolated from the extractor, and the vapours therefrom, after condensing in the condenser *C1*, flow directly through the water decanter *S1* to the extractor, where the wax extraction is effected, the solvent being at a temperature near its boiling point.

The wax solution flows to the chamber *M* and is evaporated by circulating through the heater *F*. Finally, the fatty solution in the still *B*, the wax solution in the chamber *M* and the residue in the extractor *L* are all steamed to remove the solvent therefrom.—677,330, *V. Merz.*

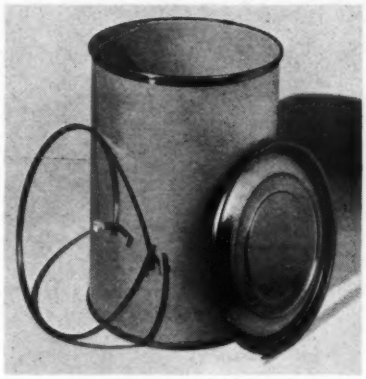
Plant and Equipment

Containers for chemicals

A new fibre drum, the *Supakask*, which was shown at the Fourth National Packaging Exhibition in London in January, has a smooth, tight-fitting steel lid and locking band and a waterproof recessed base. Other features include the steel rolling chime and beading round the rim of the tough kraft cylinder. The drum, of which pilot-plant production has only recently begun, was exhibited by the Packaging Division of the Bowater Organisation, along with the full range of Bowater drums.

Also shown by this company were automatic scales weighing to a tolerance of ±2 oz. in 1-cwt., high-speed filling machines for packing all kinds of free and semi-free flowing materials into multiwall sacks and, for closing them, the Union Special sewing head, which is available with either a trolley base or, for high outputs, a conveyor belt.

Multiwall sacks were shown with hygienic grease-resistant inner walls, for use with commodities such as raw materials for processed foods, high-grade pharmaceutical chemicals, moulding and plastic powders, etc. Bags of paper and cellulose film, waxed and laminated bags were among other Bowater exhibits.



Fibre drum.

Industrial pH amplifier and electrode assemblies

The control of large-scale chemical and electrolytic processes by methods based on the measurement of *p*H of solutions can often provide rich rewards not only by elimination of trial-and-error methods, by avoiding waste of reagents or by extracting useful materials from effluents, but also by the information it can provide to enable new products to be made. There are, however, very many problems associated with the technique: problems of viscosity, corrosion, flow, pressure, glass electrode attack and reference electrode poisoning. Many chemical firms are alive to the potentialities of control by measurement of *p*H values, but, often owing to lack of information, they are obliged to use a laboratory method of measurement, which invariably leads to loss of valuable time.

At least one manufacturer of *p*H-measuring equipment is fully aware of these problems and has devised a scheme by which they can be investigated. W. G. Pye & Co. Ltd. have recently developed a *p*H amplifier, described later, and has also built a process simulator in which these large-scale factory problems can be studied in the laboratory.

The schematic diagram on this page shows the layout of the simulator. It comprises a closed circuit of piping which embraces a reaction tank, a delay line and a circulating pump; continuous flow and immersion-type electrode assemblies can be inserted at strategic points. These electrode assemblies are connected to an electrode selector switch which, in turn, connects any one of the assemblies to the *p*H amplifier. The output from the amplifier is fed to a remote indicator/alarm relay, a recorder and a controller. The controller is linked with control valves which regulate the addition of suitable reagents contained in the tanks above them.

As described and illustrated here, the simulator is in its simplest form, but, as it is built on a demountable framework and fitted with cocks at all junctions, it is easily adaptable for use in tackling a wide variety of *p*H measurement problems.

The industrial *p*H amplifier employs a circuit, the main features of which are stated to be:

(1) Exceptional stability. Readings are unaffected by mains variations.

(2) Full temperature compensation is effected automatically.

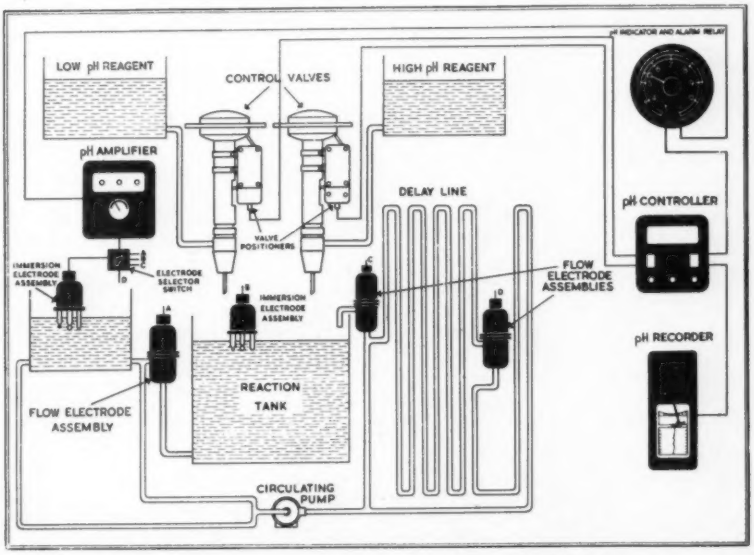
(3) Robust, flameproof case enclosing the electronic unit.

(4) The electronic unit comprises an immediately replaceable plug-in chassis.

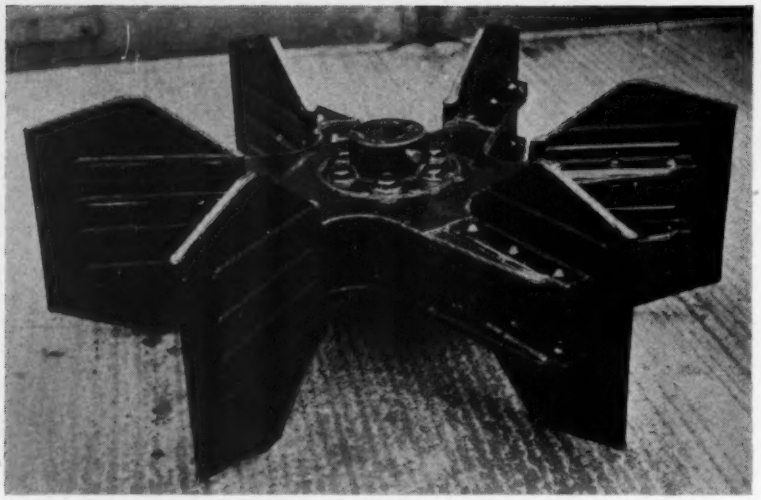
Drum heaters

Several new designs incorporating new features are included in the latest range of Heron drum heaters, which are designed to extract or liquefy materials such as grease, bitumen, resin, plastics and solidified chemicals, contained in metal drums, in a very short time. It is stated that the heater is also capable of completely drying moisture, in drums which have been washed, in a matter of seconds.

The Heron standard heater has several new features, including a



Schematic diagram of process simulator described here.



CENTRIFUGAL FAN IMPELLOR COVERED WITH PVC LAMINATE

This impellor, taken from a centrifugal fan of the paddle-blade type, 20,000 c.f.m. against 4 in. w.g., was shot blasted, coated with four coats of cement and covered with BX Plastics' Cobex/Velbex laminate by Messrs. Turner & Brown Ltd. (Industrial Plastics Division). The laminate PVC sheet was heat-formed over the metal impellor, and completely welded, thus producing a liquor- and gas-proof coating. Naturally extreme care has to be taken over work of this nature, and the covering has been designed so that all possible strain is taken off the welds; again the balance of the impellor must not be distracted by the additional weight.

change in the design of the heating element. Formerly, this was a special copper-sheathed cable wound around the inside of the strongly built lagged container. Now a steel-sheathed cable is used and this is claimed to give longer life and higher temperatures. This heater takes a 45-gal. drum, but special sizes are available to order. The heater will empty a 400-lb. drum of bitumen in 7 min. The bitumen could be completely liquefied in 4 hr. and, by means of an improved thermostatic control, be maintained at any desired temperature up to 300°C.

Two thermostats are used on the standard heater and all traces of moisture, in a drum which has been washed, can be removed in 3 min. The heater can be supplied to suit d.c., a.c., single- or three-phase, at any voltage. To use this model, ceiling space to a height of at least 15 ft. is needed. The heater is lowered into position over a drum by means of a simple pulley with counter-balance.

For premises where space is limited, a hinged version of the standard heater is available. Mounted on four castor wheels, it can be pushed into position, opened around the drum, closed, and heating is then started. Performance is similar to that of the standard model.

Another new model is the base heater. Only 3 in. high and 21 in. in diameter, the heating element is actually cast into the alloy of this model and is invisible. A drum can be easily manhandled into position over the base heater, which will fit inside the rim at the bottom of the drum. Complete liquefication of any material is achieved quickly when the base heater is used in conjunction with the standard or hinged models.

In the Heron '5' heater the heating element has been arranged to give uniform heat to the base and sides of a drum. A single thermostat is used to control temperatures up to 300°C. A hand-operated stirring paddle is fitted through the top half-cover to help speed up liquefication.

Finally a model is available designed for use in circumstances where it is necessary for the heater and drum to be lifted. A strong supporting frame to take the combined weight is fitted and clamps, operated from the outer wall of the heater, grip the drum, allowing it to be lifted safely.

The selling and marketing of these heaters was recently taken over by Houseman & Thompson Ltd.

For further details of the plant and products described, please use the coupon on page 68

NEW PRODUCTS IN BRIEF

Range of glass-fibre-reinforced sheet and tubing, *Glascorein*, claimed to have good resistance to dilute acids, moderate resistance to concentrated acids and to alkalis, and good resistance to organic solvents, except ketones and esters. (Thermo-Plastics Ltd.)

*

Aluminium piping with built-in steam line for preventing certain products from turning to solids or crystallising in the pipeline. Dual-passage extruded pipe of aluminium alloy has the main circular opening carrying the material to be transported. Beneath this, but an integral part of the tubing, is a crescent-shaped passage for steam. Savings in materials and insulation are claimed. (Joint engineering development, Aluminium Co. of America and Hercules Powder Co., U.S.A.)

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Ampoule cutting machine with output speed of 50 to 60 ampoules/min., claimed to ensure a supply of ampoules cut cleanly to an absolutely accurate length prior to fast automatic filling and sealing. The ampoules are rack-fed and rotated over a diamond which scores all round the neck. New design features are incorporated in the loading tray and delivery tray. (Autopack Ltd.)

*

Quadrant meter — an electrical measuring instrument claimed to be ideal for use where a long-scale instrument is required on equipment having a very limited space available. It occupies the same space behind the panel as a conventional meter with a 2-in. scale, but, with a front projection less than 1 in., has a scale length of 7 in. Available as a milliammeter or ammeter (range 1 ma. upwards) or as a voltmeter. (Measuring Instruments (Pullin) Ltd.)

*

New range of plastic tubing for cold liquids, claimed to possess not only sufficient elasticity to withstand high pressures and the expansion of water into ice but complete immunity to corrosion by acids, alkalis, salt water and chemical solution. Supplied in two gauges—normal and heavy. Standard screwed and compression joints may be used with the latter, but the normal gauge cannot be threaded and compression sleeve jointing is recommended. Alternatively, both gauges can be butt-welded by softening the ends near a source of radiant heat and pressing them together. (Shires & Co. (London) Ltd.)

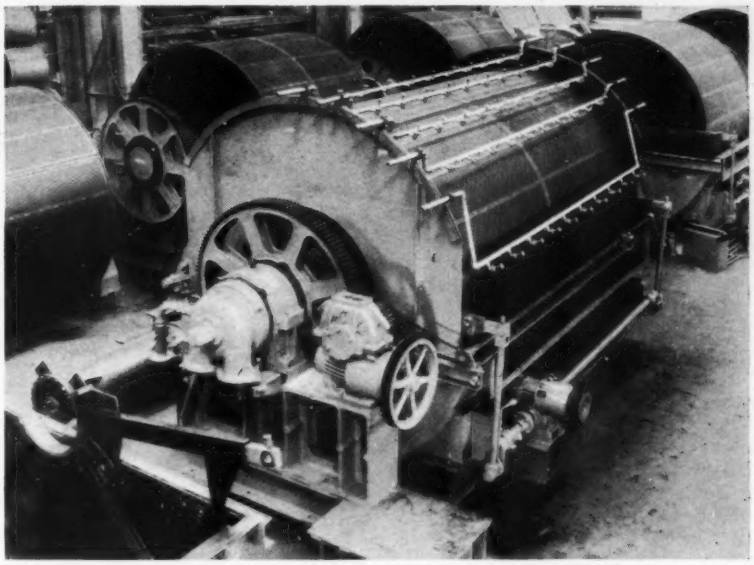
Filters and Fabrication

A VISIT TO THE DAVEY, PAXMAN WORKS AT COLCHESTER

FOUNDED in 1865 as general engineers, Davey, Paxman & Co. Ltd. in due course became one of the leading manufacturers of steam engines and boilers in the U.K. The original 'Economic'-type boiler was a Paxman patent, and until 1925 the main products of the company consisted of boilers and steam engines, though at one time or another the firm has been interested in a very wide variety of manufactures.

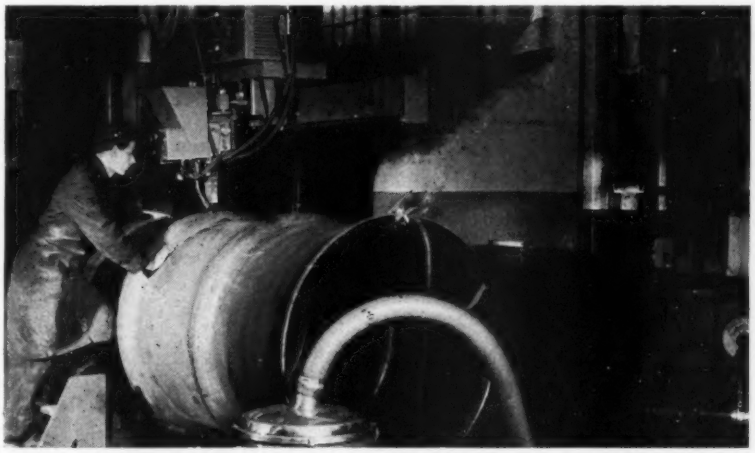
In 1925 the manufacture of diesel engines was commenced, and in recent years the company's name has been in some people's minds predominantly associated with the development and manufacture of advanced types of diesel engines. It has, however, been the policy of the firm to keep a balance between its two main activities and, although the manufacture of steam engines ceased many years ago, the boiler side of the business has continued to flourish.

Today the boiler and general engineering activities of the company are run as a separate division, as distinct from the engine manufacturing division, but with the former serving the latter where applicable and, in this connection, a notable development has been the pioneering of fabricated steel diesel engine frames which were first made in this country at the Colchester works in 1931, and which are now made in quantity for large diesel engines up to 2,000 h.p. In recent years the boiler side of the business has been extended and expanded to deal with the manufacture of many types of fabricated work as well as the Paxman rotary vacuum filter and associated products for the chemical industry.



Rotary vacuum filter in the construction bay at the Colchester works.

It was the latter aspect of the company's activities that interested us primarily when we recently accepted an invitation to visit the works at Colchester to see the progress that has been made.



X-raying a welded boiler flue. Boiler-manufacturing equipment at the Paxman works includes a special machine for spinning the ends of the boiler flue sections which are heated by a small gas-fuel furnace adjacent to the machine.

Rotary vacuum filters

One of the highlights of our visit was seeing the Paxman rotary vacuum filter in action in the company's own experimental plant, working on a test batch sent by a user for report. This type of filter is used for the continuous mechanical de-watering of slurries and it was seen that a slurry composed of 1% fibrous solid and 99% liquid is delivered in a solid cake which can be easily handled.

In the construction bay we saw a number of these filters taking shape. They are built in sizes from 2½ sq. ft. to 700 sq. ft., manufactured in cast iron or fabricated in mild steel, stainless steel, aluminium, *Monel* metal, etc., and are also covered with rubber or other acid-resisting materials according to the use they are to be put to. One 10-sq.ft. mild-steel filter seen was sheathed in rubber for filtering corrosive acids, another cast-iron filter was being erected and another was completely assembled, together with a stainless-steel model of similar capacity. The larger filter was 100 sq. ft., fabricated in mild steel and rubber covered.

One of the 10-ft. cast-iron filters, we noticed, is fully portable, and it was explained that it is of the type loaned to prospective customers so that they may test its suitability.

Chemical slurries, food products, starches, paper pulp, effluents, coal slurries, various lime sludges and mud are among the materials for which Paxman filters can be used.

Other types of filters

The *Acco*-type rotary disc filter is produced in conjunction with the Automatic Coal Cleaning Co. Ltd., of Carlisle. This filter is again designed for continuous separation of solids and liquids and is particularly suited to treat flotation froths and raw slurries. It was interesting to note the rapidity with which the discs, each of which comprises an assembly of interchangeable segments, could be erected or dismantled.

As an alternative method of separating solids from liquids continuously as opposed to centrifuges which work on the batch system, Paxman manufacture the Bird centrifuge filter for Vickerys Ltd., who hold a licence from the original American manufacturers. The example we saw was fabricated from stainless steel. We also saw parts of two further stainless-steel filters which were being constructed. The bowls, spiral conveyor and tube holes are hard-faced with a special wear-resisting material welded to the main structure.

Paxman also design band filters to the requirements of sugar manufacturers, who use them to wash and de-water the charcoal used in the refining process. In this way the charcoal can be used repeatedly.

Fabrication of pressure vessels, etc.

We were looking forward to seeing something of Paxman's work on the welding of pressure vessels and we were not disappointed, for an excellent example of this work in stainless steel was in the final stage of completion. This was a cylindrical pressure vessel having semi-elliptical ends, measuring about 9 ft. diamater by 12 ft. 6 in. high. This, we were told, had been tested to 154 lb. hydraulic pressure and 28 in. of vacuum. It was constructed of stainless steel $\frac{3}{8}$-in. thick and welded by both electrical metal arc and the inert-gas-shielded process.

An all-steel sectional boiler was also under construction. Three of these boilers, completely automatic in action, supply space heating to a number of the company's new shops and offices.

The frames of diesel engines are fabricated from mild-steel plate, and we saw the crankcase and the bedplate of the mark 'YL' engine range which develop up to 2,000 h.p. in the 16-cylinder form. These fabricated engines are for industrial, marine and locomotive use.

Three forms of welding are in common use. The inert-gas-shielded process is used mainly for non-ferrous metals and stainless steel. Examples of this welding included stainless-steel pressure vessels. Argon-arc welding is used mainly for non-ferrous light plate work up to $\frac{3}{16}$-in. thick, while the Lincolnweld automatic submerged arc welding method is used for welding mild-steel flues for boilers, also for Class I pressure vessels in mild steel, and for the all-welded and shell types of boilers.

In the main welding bay the old canvas screens previously used have been replaced with cubicles built from standard Dexion sections with hardboard panels. To save space and keep clear gangways, each cubicle has been fitted with a sliding door. The cubicles are painted matt eau-de-nil green to minimise the effect of flash and glare from the welding. The company find this form of panelling, besides being convenient, has one great advantage in that it can be cheaply and conveniently repaired if damaged. The whole welding bay is well served with cranes and there is the added advantage that plate preparation, fabrication and machining is carried out in the same shop.

A recent extension to stress-relieving facilities at Colchester has been the installation of a town-gas-fired Dowson & Mason stress-relieving furnace. This furnace will take vessels 27 ft. long and 9 ft. 6 in. in diameter, and is fully automatic. Temperature and programme control is fitted to ensure that the correct temperature cycle for each type of fabrication is achieved.

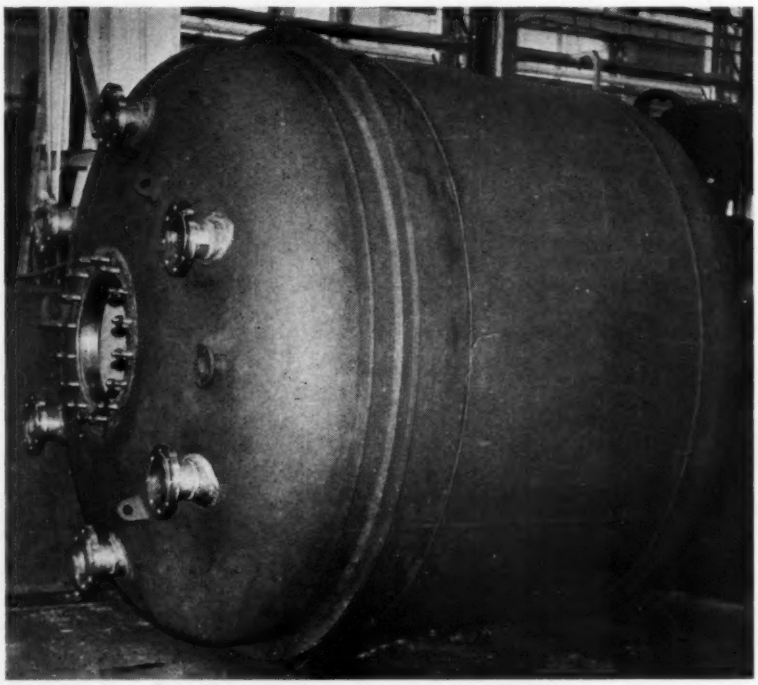
Tools and equipment

The works are well equipped for plate preparation and bending plant, primarily to deal with the manufacture of boilers. There is a wide selection of machine tools and we noted work in progress on a Butler planer, a 12 ft. 6 in. vertical borer and a Richards horizontal borer. Besides the machines in this division of the works, Paxman have a wide selection of small machine tools.

There is a well-equipped tool room and a cutter grinding shop in which all jigs and tools, etc., are made.

The standards room, which we found in an air-conditioned and temperature-controlled building, has recently been re-equipped. Amongst the equipment is the necessary testing apparatus for testing the strength of materials.

There is a separate quality control department coming under the immediate supervision of the directorate.



A stainless-steel welded pressure vessel.

World News

GREAT BRITAIN

Big 'Terylene' plant in operation

As we go to press the first unit of Imperial Chemical Industries' £20-million *Terylene* plant at Wilton, Yorkshire—the first large-scale plant to produce this polyester fibre—has come into partial production. This first unit will have a capacity of 11 million lb. p.a., half being filament yarn and half staple fibre. The second unit, which will be completed during 1955, will double the capacity. In the first unit, about 800 men will be employed on processing and plant maintenance.

It will be some months yet before every unit of the complicated chain of new processes is at full capacity. Para-xylene from the Wilton olefine plant is converted to terephthalic acid and this is processed with methanol, forming dimethyl terephthalate which is then purified. The dimethyl terephthalate is reacted with ethylene glycol to give di-hydroxyethyl terephthalate. This is polymerised. The resultant polyethylene terephthalate (*Terylene* polymer) is converted to filament yarn or staple fibre.

Work began on the foundations of the *Terylene* plant, which covers 30 acres, in May, 1952. In the summer of 1953, construction of the buildings began. More than 3,000 tons of structural steel and 40,000 cu. yd. of concrete were used.

Until recently, the production of *Terylene* had been confined to the output of the pilot plants at Huddersfield, Yorkshire, and Fleetwood, Lancashire, which are currently producing at the rate of some 2 million lb. p.a.

Wilton is the biggest single project in the history of the British chemical industry. It forms, with I.C.I.'s works at Billingham, to which it is linked by pipelines, one of the greatest concentrations of chemical industry in the world.

Fertiliser factory reconstruction

Scottish Agricultural Industries Ltd. are embarking on the reconstruction of the fertiliser factory at Leith, it was stated by the company's chairman, Sir William Gavin, C.B.E., in his annual review.

This project is only in its initial stages, but the company have secured from the Leith Dock Commission additional land adjacent to the existing works and alongside the Imperial and Edinburgh Docks. Here it is proposed to erect new buildings to handle and store the main raw materials which are sea-borne, and to house manufacturing plant of large capacity and new design for the production of high-quality compound and phosphatic fertilisers. The present site will then be used to provide storage, packing and despatch facilities for the finished fertilisers, for distribution by road, rail and sea.

The company expect to complete this programme over the next three or four years.

Factory equipment exhibition

The third National Factory Equipment Exhibition opens at Earls Court, London, on March 28. Concurrently with the six-day exhibition, the National Industrial Fuel Efficiency Service is presenting a series of talks on ' Fuel Efficiency Pays '; the British Productivity Council, a one-day conference on ' Work Study,' illustrated by practical films; and the Institution of Works Managers will hold their national conference during the last three days of the exhibition.

No sugar-beet factory for south

The Ministry of Agriculture has decided against erecting a sugar-beet factory to serve the south of England. It has been decided that the savings in operating and transport costs such a factory would produce for the British Sugar Corporation would not balance the capital outlay of £3 million. Also, the Government could not at present contemplate an increase in the sugar-beet acreage.

Chemical factory's safety record

The employees at the Ruabon factory of Monsanto Chemicals Ltd. recently completed two million man-hours of work without a single lost-time accident. The factory employs approximately 2,000 men and women on the production of industrial chemicals and commenced its unbroken accident-free run on July 17, 1954.

This establishes a new record for the Ruabon factory, the best previous achievement being 1,799,670 accident-free man-hours set up in June 1938.

Resin processing plants on show

During the last 12 months there has been a keen demand for resin processing plant, particularly for the production of alkyd resins by the solvent process. Metal Propellers Ltd. state that, to meet this demand, they have prepared a complete new range of designs which will be suitable not only for the solvent process, but also for the fusion process, which is still widely favoured.

A new range of dual-purpose, stainless-steel resin plants will be the main theme of the photographs and diagrams exhibited by this firm at the

Functions and Education of the Chemical Engineer in Europe

ELEVEN Western European countries are expected to take part in a conference on the above subject which is to be held in London on March 21, 22 and 23, and at present the likely attendance is estimated at 400.

The conference has reference to the recommendations made in the O.E.E.C. report, 'Chemical Apparatus in the U.S.A.' (Paris, 1952). The object is to draw attention to three main requirements in Europe in the rapidly growing field of chemical engineering:

(a) The necessity for more chemical engineers and more schools of chemical engineering.

(b) The necessity for more financial aid for chemical engineering research.

(c) The necessity for a more general recognition of the part that chemical engineering is playing in modern industry.

A provisional programme issued by the Institution of Chemical Engineers lists about 30 papers to be presented during the six sessions. The chairman of the first session will be Sir Harold Hartley, K.C.V.O., C.B.E., M.C., D.C.L., F.R.S., president of the Institution, and papers are being presented by many eminent authorities from all over Western Europe.

The conference is organised by the Institution in co-operation with the Department of Scientific and Industrial Research for the European Productivity Agency of the Organisation for European Economic Co-operation.

The importance of this conference to the chemical engineering profession in Europe needs no stressing on our part. It should result in some valuable conclusions which we hope to bring to the attention of our readers in due course.

Oil and Colour Chemists' Association Exhibition in March. Plants for the processing of phenol formaldehyde and other synthetic resins, as well as stand oil plant, are also covered by up-to-date design involving a variety of alternative methods of heating and cooling.

Blast furnaces for India

A contract for two large blast furnaces, amounting in value to nearly £3 million, has been placed by the Indian Iron & Steel Co. Ltd. with Ashmore, Benson, Pease & Co., of Stockton-on-Tees. The furnaces, to be built at Burnpur, India, will have hearths of 25-ft. diameter and each will be capable of an output of 1,200 tons/day or iron. This contract has been awarded to the British firm in the face of keen competition from both the Continent and the U.S.A.

Symposium on reinforced plastics

A one-day symposium on reinforced plastics will be held on Thursday, February 17, at the College of Technology, Suffolk Street, Birmingham. The symposium will review methods of manufacture, properties and applications of structures based upon glass and asbestos fibre impregnated with synthetic resins. The proceedings will, therefore, interest both the manufacturer and the user and should be of particular concern to those investigating the use of these materials for structural and engineering purposes.

Plastic raw materials manufacture

The manufacture and sale of moulding powders, synthetic resins and other plastic raw materials, at present carried out by British Industrial Plastics Ltd., has been transferred to a wholly owned subsidiary company, B.I.P. Chemicals Ltd. This newly formed company will take over responsibility for all the technical, design and sales service at present provided by the parent company and will maintain the same offices.

Summer School of Welding

The fifth Summer School of Welding, organised by the British Welding Research Association, will be held at Ashorne Hill, near Leamington Spa, from June 27 to July 2, 1955. The school takes for its basic theme, 'Welding Developments in British Industry,' and students will be divided into four groups devoted to: pressure vessels, transport, shipbuilding and specialised welding techniques. It is possible that an additional group on 'inspection and testing' will also be included.

The A.B.C.M. and the B.I.F.

The Association of British Chemical Manufacturers has decided to take part once more in the British Industries Fair in London. At the 1955 B.I.F. a single exhibit will be staged representing the chemical industry. This will be followed in 1956 by full-scale participation in which individual companies will take part in a co-ordinated display of major importance.

The 1955 exhibit is in the nature of a 'holding operation' intended to support British Industries Fair Ltd. in its initial venture and enable the industry to prepare itself for a publicity effort of major size in 1956.

Change of name

Blick Engineering Ltd. are changing their name to Blickvac Engineering Ltd. and are acquiring the high-vacuum engineering business of 'Blickvac.'

Film tells oil refinery story

The construction and opening of Coryton refinery are described in Vacuum Oil Co.'s latest film. The film, a documentary which is essentially non-technical, runs for about 30 min.

SWEDEN

Bleached sulphite production

The Bergvik & Ala Nya Aktiebolag, of Soederhamn, which up to now has been producing only unbleached sulphite and sulphate pulp, has decided to start production of bleached sulphite pulp. The company plans to set up a bleaching plant to process the whole of the output of the Bergvik factory; this has an annual capacity of about 50,000 tons of unbleached sulphite.

The sulphate factory at Sandarna will continue to produce unbleached pulp.

HUNGARY

Ammonia synthesis

A new ammonia synthesis plant is being tested at the Borsod chemical works at Kazincbarcika, the big industrial area now being developed in north Hungary.

The 3,000 h.p., 6,000-v. electric motor which operates the giant compressor was given its first run recently. The compressor is stated to be unique in Hungary. Test production began soon after the compressor had been assembled.

NORWAY

Need for atomic power

It is calculated that Norway must build her first atomic power station in 1975 in order to supplement the amount of energy produced by water power, said Dr. Gunnar Randers, the Norwegian director of the joint Norwegian-Dutch atomic research institute at Oslo recently. Dr. Randers is special adviser on atomic questions to U.N. Secretary, General Dag Hammarskjöld.

INDIA

Soda ash projects

Two new soda ash factories are to be set up at Porbandar in Saurashtra and at Tuticorin in southern India; a third may be added in Bihar. Details of their capacity have not so far been given, but if they are planned along the lines recommended by the Planning Commission, together with the two existing plants they should meet India's requirements.

Import licensing policy

With a view to reconciling conflicting interests of producers and consumers of industrial materials, the Government of India intend to canalise imports through suitable channels. Imports of sodium bicarbonate, caustic soda, soda ash and muriate of potash, etc., are to be entrusted to some kind of autonomous corporation or authority, whose policy is based on public interest and not on the profit motive. The scheme is yet to be completed and the Government is expected to announce in due course the channels through which each item can be imported.

Sindri coke-oven plant

The 25-million-rupee coke-oven plant of the Sindri fertiliser factory was formally inaugurated recently. The plant comprises a battery of 60 ovens each with a capacity to take 10½ tons of coal. When in full production, the plant is expected to yield 600 tons/day of coke, 10 million cu. ft. of gas, 32 to 35 tons of tar, 2 tons of ammonia and 9 tons of crude benzole.

PAKISTAN

Foreign capital investment

The Pakistan Government has announced a list of 27 industries which have been added to those enjoying the benefits of the Government's incentive scheme for foreign capital investment.

Benefits apply to companies started after September 1, 1954, and include unrestricted repatriation of investments and ploughed-back profits, just compensation in the case of nationalisation and share control of up to 60% of capital issued in Pakistan.

New additions to the list of industries include: cement and cement products; edible oils (hydrogenated

or otherwise); heavy chemicals; iron and steel; manufactures of heavy engineering industry; minerals (including salt and coal); non-ferrous metals and alloy manufactures; paper cardboard and pulp; petroleum and mineral oils; pharmaceuticals, drugs and light chemicals; power and industrial alcohol; preserved and prepared foods; and products of carbonisation industry.

It was also announced that the Pakistan Government would, in addition, consider on their merits applications for the above facilities to be granted to foreign investment in other industrial concerns. A communique said that henceforth all companies which had foreign investment as part of their capital structure would have to obtain prior approval for issuing capital in Pakistan.

BELGIAN CONGO

Cottonseed oil and cake factory

The construction of a new factory for the production of cottonseed oil and oil-cake has recently been completed at Gossamu, near Paulis. The factory is able to deal with 16,000 to 17,000 tons p.a. of cottonseed and is expected to produce 2,400 tons of oil and 6,400 tons of cake.

COLOMBIA

Pipeline project

The Texas Petroleum Co. is planning a 160-km. pipeline for petroleum products from Puerto Nino, on the Magdalena River, to Galan, their distribution centre for Santander. The reconstruction of the Puerto Berrio-Medellin pipeline has been completed. It is proposed to link it up to the National Petroleum Enterprise's pipeline from Cantimplora to Puerto Salgar.

FRANCE

Synthetic rubber project

A company to produce synthetic rubber in France will be formed shortly. The company, to be called Société du Caoutchouc Butyl, will be founded by 10 prominent firms comprising two petroleum companies, three tyre manufacturers and five chemical companies.

Reuter reports from Paris that a plant will be erected in the Rouen area. It is being planned for a capacity of 20,000 tons p.a. of butyl rubber. Operations are expected to start in 1957. The isobutyl required will be supplied by the refineries of the two participating oil companies — Esso Standard and Compagnie Francaise de Raffinage.

The plant is expected to make France independent of imports with a resultant dollar saving of about $5 million p.a.

CANADA

Nickel industry still expanding

The consumption of nickel for catalysts in the chemical and allied industries in 1954 increased greatly over that of 1953, according to Dr. J. F. Thompson, chairman of the International Nickel Co. of Canada Ltd. In a review of the nickel industry made just before the end of 1954, he stated that nickel production by the free world in 1954 would reach an all-time high estimated at 390 million lb. or some 50% higher than the pre-Korean 1949 output. The 1954 production is 50 million lb. higher than the free world output in 1953. Much of this increase was assisted by Government premium prices.

It is expected that overall production by Canadian producers will surpass that of any previous year and will come to about 320 million lb., accounting for over 80% of the free world's total. In 1953, Canadian nickel production totalled 286 million lb.

Output of the metal by International Nickel from its own ores during the year will also set a record at about 275 million lb. This high nickel production has been made possible by reason of the completion of certain mining and metallurgical developments after years of planning and research, and of the progress made in Inco's underground mining expansion programme.

It is estimated that free-world nickel production in 1955 should approximate 415 million lb. It is expected that, after satisfying defence requirements and deliveries to Government stockpiles under present schedules, more nickel will be available to industry for civilian applications in 1955 than was the case in 1954.

An expanding market for nickel is foreseen not only in the jet aircraft industry but in industry generally as a result of the anticipated adoption of the gas turbine for many industrial purposes.

Sulphuric acid project

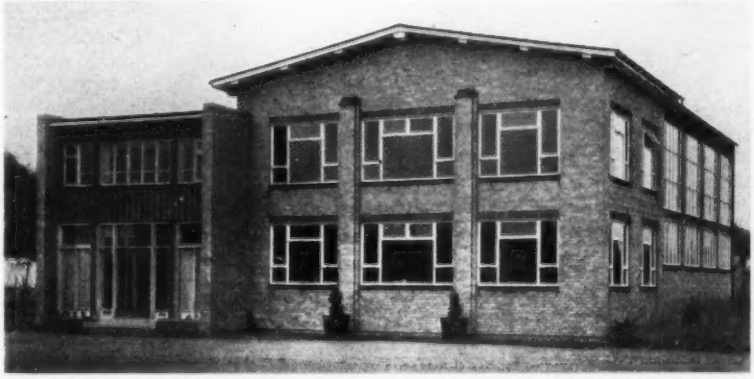
A 100-ton/day plant to make sulphuric acid is to be built at Fort Saskatchewan, Alberta, by Inland Chemicals Canada Ltd., a newly formed company. The construction contract has gone to the Lummus Co., of Canada.

The plant, expected to be completed next summer, will be situated clost to the nickel-ore-processing plant of Sherrit-Gordon Mines, who will become one of the major customers.

WESTERN GERMANY

Nitrogen from coke-oven gas

A further stimulus will be given to the economy of the Salzgitter area of Lower Saxony if plans to erect a nitrogen plant at Salzgitter-Druette are realised. The new plant, with an annual output capacity of 50,000 metric tons, would be built by the Mining & Steel Works Co. (A.G. für Berg und Huettenbetriebe), formerly part of the Hermann Goering complex and now owned by the Federal Government. The plant would use the gas produced at the cokeries of Salzgitter Steel Works, another subsidiary of the Mining & Steel Works Co., as a chemical raw material. The output could be readily disposed of to the federally owned Nordchemie Co. at Goslar and Mehlbeck, to be used in the production of artificial fertilisers and saltpeter.



Stockdale Engineering Ltd. have recently decided to extend the floor area of their Poynton works by some 80% of the present area. The works, as it stands today, was completed in the early part of 1953.

UNITED STATES

Pure manganese production

Union Carbide & Carbon's electrometallurgical company division has started production of 99.9% pure manganese metal in the form of plates at a new plant in Marietta, Ohio, the company announces. The new plant will have a capacity of about 6,000 tons p.a. when in full operation.

The pure manganese will make it possible for steel companies to produce newly developed manganese-chromium stainless steels, which require less nickel.

Polyisocyanate manufacture

The Du Pont company is planning to build additional facilities to manufacture polyisocyanates—a group of chemicals used in the manufacture of adhesives, plastics and a new variety of rubber. The new plant will be erected at Deepwater Point, New Jersey. Completion is scheduled for mid-1956.

Chemical factory for Brazil

The U.S. Export-Import Bank has announced the granting of a credit for $1½ million to help finance the construction of a chemical factory in Brazil. The credit was made to W. R. Grace & Co. and the American Home Products Corp. These two firms will combine with the Brazilian Fongra Produtos Quimicos S.A. of Brazil to form a new company.

The new company will build a factory, at Suzano, about 30 miles east of Sao Paulo, to manufacture DDT insecticide, industrial solvents, detergents, caustic soda, chlorine and other chemicals.

Sulphur's record year

The U.S. sulphur industry broke all past production records in 1954 and began the year with sufficient productive capacity to satisfy all demands upon it, both domestic and export. This was reported by Mr. Charles A. Wight, chairman of the executive committee of Freeport Sulphur Co., in a year-end review of the industry. He estimated that U.S. production of sulphur from all sources in 1954 reached 6,600,000 long tons, or 350,000 tons more than in 1953. Most of this production came from the salt dome deposits in Louisiana and Texas mined by the Frasch hot-water process. Productive capacity was now at an all-time high, he said, and was ample to meet all demands of consumers at home and abroad.

The U.K., which depends upon the U.S. to fill about a third of her sulphur needs, imported about 400,000 long tons in 1954, or approximately 200,000 tons more than in 1953.

The estimate of 6,600,000 long tons of sulphur produced in 1954 is based on preliminary figures. Of the total, an estimated 5,450,000 tons was Frasch process sulphur, 350,000 tons was sulphur recovered from gases, 400,000 tons was sulphur contained in pyrites and 400,000 tons was sulphur in various forms from other sources.

Output of Frasch sulphur was about 300,000 tons more than in the previous year. The gain was made possible by the successful operation of Garden Island Bay, Freeport's new mine at the mouth of the Mississippi. This $14-million mining plant, completed late in 1953, produced in excess of 500,000 tons in 1954. Output of non-Frasch sulphur increased about 50,000 tons over the previous year. A total of 10 projects for recovery of sulphur from sour natural gas and refinery gases and for production of sulphur in various other forms went into production or neared completion in 1954. Efforts to increase the sulphur supply include a new Frasch project at Chacahoula dome in Louisiana and eight other projects of various types.

RECENT PUBLICATIONS

Acid-resisting cement is described in a new leaflet by J. H. Sankey & Son Ltd. The cement is used chiefly for bedding and jointing vitrified bricks and tiles in the construction of acid-resisting floors, walls and tanks. It is also used for jointing pipes carrying acids and acid fumes.

Centrifugal pumps. A new 18-pp. illustrated brochure from Wilkinson Rubber Linatex Ltd. features the range of Linatex centrifugal pumps. These are stated to be suitable for pumping many chemical solutions, acid or alkaline, at moderate temperatures, and for the disposal of effluent, and, apart from the chemical industry, examples are cited of applications in collieries, steelworks, cement factories, paper mills, etc. Design features of the pump are pointed out and some typical installations are illustrated. Instructions for selecting a suitable pump, with diagrams and tables, are also included.

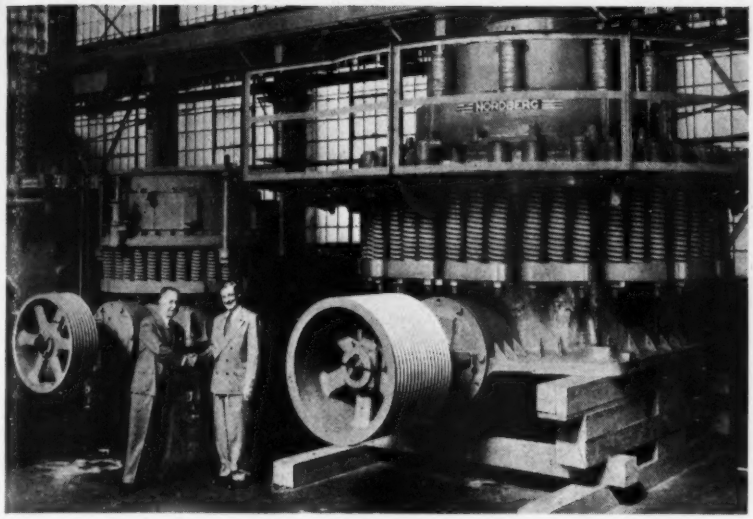
Infra-red methods and light hydrocarbon gas analyses. A 12-page illustrated paper outlining the application of infra-red methods to light hydrocarbon gas analyses comes from the Perkin-Elmer Corporation, U.S.A. Most of the paper is given over to a detailed example of the procedure and calculations involved in a typical five-component analysis. The paper also outlines the advantages of infra-red and mass spectrometer methods, describes the infra-red instrumentation required for typical light hydrocarbon gas analysis, and the services and laboratory space needed. It was originally presented by P. A. Wilks at the Symposium on Methods for Testing Liquefied Petroleum Gases, September 27, 1954.

Automatic packaging. From Autopack Ltd. we have received the first issue of a new illustrated publication, *Autopackaging*, which contains articles on automatic weighers and other Autopack machines, as well as miscellaneous features.

Mechanical overloading shovel. From Merton Engineering Co. Ltd. come two illustrated pamphlets featuring the new Mark V Merton overloader, which has a ¾-yd. bucket and a loading rate of 3 to 4 buckets/min. New features include the enclosed cab, full-width bucket, variable discharge height and other points.

Metal framing. Various applications of the *Unistrut* metal framing system are described and illustrated in a 16-pp. catalogue issued by Sankey-Sheldon Ltd. All kinds of metal framing structures can be made up without the need for welding or drilling, and the assemblies can be dismantled and the components used again. The basic components are *Unistrut* channel, 12 gauge, supplied in 10 ft. and 20 ft. standard lengths; locking nut; bolt; and framing fittings. Other *Unistrut* components include cable, pipe and conduit clamps, and concrete inserts, with a continuous slot that permits attachment anywhere along the channel run. The catalogue illustrates numerous *Unistrut* assemblies for supporting pipes, tubing, etc., in various circumstances, as well as racks, shelving and other structures. Some useful design data and specifications are included.

Silver plating is the subject of a new 36-page booklet (No. 1851) which has been added to Johnson Matthey & Co.'s range of technical literature. It is not intended to be an exhaustive treatise on the electrodeposition of silver, but deals in a practical manner with the various operations involved in silver plating, indicating suitable methods for most requirements and giving warnings of possible difficulties.



Mr. Robert E. Friend, president of the Nordberg Manufacturing Co., U.S.A., congratulates Mr. J. B. Bond, assistant general manager and sales manager of the firm's Crusher Division, on completion of the 5,000th Symons cone crusher. This machine is one of the 37 super-heavy-duty 7-ft. crushers destined for the North Central United States iron ore range to process Taconite. Crusher No. 5001 on the left is a 4-ft. Symons cone which will be shipped to a well-known slag producer.

★ PERSONAL PARAGRAPHS ★

★ **Mr. W. J. V. Ward,** who has been technical director of the Billingham Division of Imperial Chemical Industries Ltd. since 1949, has been appointed chairman of the Division in succession to **Dr. G. I. Higson,** who is retiring. Mr. Ward joined the Billingham Division in 1926 and worked at first in the research department. By 1932 he had risen to be senior plant manager in the process department and later in the same year took charge of the 'Drikold' group. For four years he was chief technical assistant on the directorate staff, and in 1944 joined the Division technical department as ammonia technical manager. He was later promoted to take charge of the technical department, relinquishing this position in December 1949 on his appointment to the Division board as technical director.

Dr. Higson joined the Division in 1922 and, with the exception of two years during which he was seconded to Canadian Industries Ltd., has spent the whole of his company service at Billingham. For a number of years he was technical department manager and was appointed successively technical director and joint managing director. He became chairman of the Division in 1951.

★ **Mr. Harold J. Cotes,** managing director of British Glues & Chemicals Ltd., began his career in the glue industry 50 years ago at a small factory in the Midlands. To commemorate this long association, his colleagues on the board and employees have presented him with his portrait in oils, painted by Mr. Cowan Dobson, R.A.

★ Babcock & Wilcox Ltd. announce that, in view of their expanding activities in Latin America, **Mr. A. S. Peacock** has been appointed as manager for that territory, with general responsibility for the company's business in Latin America, including factory development in Brazil and co-ordination of policy.

★ **Mr. F. B. Marmoy,** A.R.I.C., has joined the research staff of British Filters Ltd., where he will be in charge of the microbiological laboratory. He was recently concerned with the development of the Industrial Products Department of Messrs. Ward, Blenkinsop & Co.

★ The Association of British Chemical Manufacturers has appointed **Mr. Christopher J. Pratt** as work study and productivity officer. He will be responsible for helping members on all aspects of work study as applied to the chemical industry.

★ **Mr. Alan Melbourne,** export sales manager of Joseph Crosfield & Sons Ltd., will be visiting, during February and March, markets in the Mediterranean and Middle East areas in connection with the sales of silicates, detergents and ion-exchange materials. Countries to be visited include Egypt, Sudan, Lebanon, Turkey, Greece, Cyprus, Malta, Libya, French Morocco, Gibraltar and Portugal. **Mr. David Sinclair** has left Crosfield's head office to take up the appointment of assistant sales manager, southern area, and moves to their London office. **Mr. Paul Mangan,** who has assisted Mr. Sinclair in Crosfield chemical advertising, has been appointed advertising manager.

★ **Mr. A. de M. Browne,** managing director of the Hackbridge & Hewittic Electric Co. Ltd., has recently been appointed chairman of the company. He joined the Hewittic Electric Co. Ltd. as technical development engineer in 1924, became chief engineer in 1930 and manager in 1936. He was appointed director in 1939 and, concurrently, sales director of Hackbridge Electric Construction Co. Ltd. in 1941, becoming director of both companies after their amalgamation in 1947. He is also a director of the New Switchgear Construction Co. Ltd. and president of the Hackbridge & Hewittic Electric Co. of Canada Ltd.

★ **Mr. Harry J. Haon** has been appointed manager of the European office of E. I. du Pont de Nemours & Co. **Mr. Stanley R. Stager, jun.,** who has been manager of the European office since 1952, is returning to a new appointment at the company's headquarters.

★ **Mr. H. W. Barnett,** London manager for the Butterley Co. and subsidiary Hughes & Lancaster, also manager, Oxygen Division, has resigned after 18 years' service. He is starting his own advertising business.

★ Changes on the board of Quickfit & Quartz Ltd. are announced. **Lord Stanmore** (83) has resigned on the grounds of age, having been a Quickfit director since 1946. **Mr. Brian H. Turpin** and **Mr. Arthur Cochrane** have offered their resignations. Mr. Turpin is now fully employed as managing director of the Q. & Q. subsidiary, Q.V.F. Ltd., the selling organisation for glass industrial plant and glass pipeline. In tendering his resignation, Mr. Cochrane, who is assistant managing director of the Triplex Safety Glass Co. Ltd., said he felt that he should facilitate the promotion of younger members of the staff to the Q. & Q. board. Accordingly, the board have co-opted as directors **Mr. D. Curtis,** the firm's development manager, **Mr. E. L. Harrison,** sales manager, and **Mr. E. S. Pearse,** works manager.

MEETINGS

Institution of Chemical Engineers

February 18. 'A New Technique for Particle Size Distribution Analysis by Centrifugal Sedimentation,' by J. K. Donoghue and W. Bostock, 7 p.m., College of Technology, Manchester.

March 2. 'Instrumentation of a Nuclear Power Plant,' by P. V. Koller, 7 p.m., The University, Leeds.

March 9. 'Instrument Performance in Industrial Applications,' by J. Illingworth, 6.30 p.m., The University, Edmund Street, Birmingham.

Chemical Engineering Group (Society of Chemical Industry)

February 18. 'Some Applications of Chemical Engineering in the Fine Chemicals Industry,' by W. C. Peck; 'Vacuum and Freezedrying,' by A. S. D. Barrett, 7 p.m., King's College, London. Joint meeting with Fine Chemicals Group.

February 24. 'Mechanics of Droplets and Bubbles in Diffusion Processes,' by Prof. F. H. Garner, 7.30 p.m., North British Station Hotel, Edinburgh. Joint meeting with R.I.C. and the Chemical Society.

Institute of Petroleum

March 9. 'The Viscosity of Liquid Hydrocarbons,' by L. Grunberg, 5.30 p.m., 26 Portland Place, London, W.1.

The Chemical Society

February 17. 'New By-products from Coal,' by Dr. W. Idris Jones, 7 p.m., College of Technology, Gloucester. Joint meeting with R.I.C. and S.C.I.

February 25. 'Corrosion Processes: Their Causes and Prevention,' by Dr. F. Wormwell, 7.30 p.m., Robert Gordon's Technical College, Aberdeen.

February 25. 'Mineral Analysis,' by Prof. L. S. Theobald, 5 p.m., The University, Southampton.

February 28. 'The Kinetics of Halogenation Reactions,' by R. P. Bell, 5 p.m., University College, Leicester.

March 1. 'Liquid Crystals,' by Prof. B. Jones, 5.15 p.m., Queen's College, Dundee.

Institute of Metals

March 1. 'Plutonium: Some Properties and Handling Problems,' by W. B. H. Lord, 7 p.m., Ballroom, Cadena Cafe, Cornmarket Street, Oxford.

March 3. 'Physical and Chemical Processes Occurring in the Electrolytic Production of Aluminium,' by T. G. Pearson, 6.30 p.m., 4 Grosvenor Gardens, London, S.W.1.

March 3. 'Recent Developments in Stainless Steels,' by J. I. Morley, 6.30 p.m., James Watt Memorial Institute, Great Charles Street, Birmingham.

Fertiliser Society

February 24. 'Works Structures,' by R. F. Miles, and 'Construction Materials in the Fertiliser Industry,' by C. W. Marler, 2.30 p.m., Geological Society, Burlington House, Piccadilly, London, W.1.

Incorporated Plant Engineers

February 15. 'Refrigeration as Affecting Industry,' by D. E. Hall, 7.15 p.m., Mackworth Hotel, Swansea.

February 17. 'Statutory Requirements in Connection with Boilers and Other Pressure Vessels,' by G. A. Anderson, 7.30 p.m., Golden Lion Hotel, Blackburn.

February 17. 'Electronic Control,' by G. Horsfall, 7.15 p.m., Royal Institution, Colquitt Street, Liverpool.

CHEMICAL & PROCESS ENGINEERING

ENQUIRY BUREAU

Stratford House, 9 Eden Street, London, N.W.1

Readers requiring names of suppliers of raw materials, machinery or finished products should complete this form and attach it to their business note-heading. Please state approximate quantities required.

We wish to know names and addresses of suppliers of the following:

_____

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For office use only. No. Date

Export Opportunities

Heavy chemicals

Mr. W. A. Bentel, manager of the merchanting branch of the Burkhart-Schier Chemical Co., 1228 Chestnut Street, Chattanooga, U.S.A., is interested in receiving offers from United Kingdom suppliers of heavy chemicals. The firm are manufacturers of chemicals for the textile trade. (For further particulars, apply to the Board of Trade, London, quoting Reference E.S.B. 28234/54.)

Acid oils, greases and fats

Isaac Totah & Sons, 11 rue Sinan Pasha, P.O. Box 1355, Alexandria, Egypt, want to get in touch with United Kingdom producers or exporters, who are not already represented in Egypt, of acid oils and greases and fats for soapmakers. (Reference E.S.B. 25595/54.)

Direct-Fired Heaters

(*Concluded from page* 49)

can be maintained on the flows and these adjusted as necessary.

A few suggested points to check before the purchase of heating equipment are:

(1) What is the thermal efficiency expected?
(2) How much excess air is used in combustion?
(3) Are parallel passes controlled?
(4) What is the maximum heat-transfer rate?
(5) Are large quantities of refractory used and, if so, why?

These are in addition to the normal check on safety and ease of operation. The key to the last point is that high-temperature insulators are readily available from the manufacturers. For some of these, working hot face temperatures of up to 2,600° are claimed by the manufacturers. If it is necessary to install refractories, the temperature of the hot face must be 2,000°F. or more, so that very high heat-transfer rates will result. This does not, of course, apply immediately around the burners, but refractory walls should not be installed out of the hot plane. If one is heating a heat-transfer oil or fluid to, say, 600°F., a question is needed to find out why the refractory is required.

The Editor is always pleased to consider articles submitted for publication. A preliminary letter or synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.